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Section D BOTANY

Bull. Res. Counc. of Israel. D. Bot.

Continuing the activities of the
Palestine Journal of Botany,
Jerusalem and Rehovot Series

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MIRIAM BALABAN
Editor

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3. TAYLOR, G. I., 1932, *Proc. roy. Soc.*, A138, 41.

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4. JACKSON, F., 1930, *Thermodynamics*, 4th ed., Wiley, New York.

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THE MYCOFLORA OF OVERWINTERED CEREALS AND ITS TOXICITY

A. Z. JOFFE

Department of Botany, The Hebrew University of Jerusalem

ABSTRACT

Within the framework of studies on the etiology of alimentary septic angina, an investigation was carried out during the years 1943–50 to determine the toxicity of fungi on overwintered cereals.

A total of 192 fungus species were isolated from samples of cereals overwintered in the field under snow-cover, of summerharvested cereals and of soils on which the cereals concerned had been grown. Large numbers of isolates from overwintered cereals were found to be toxic when applied to the skin of rabbits. Isolates from summer-harvested cereals were not toxic.

The fungal species of which toxic and highly toxic isolates were most common were *Fusarium poae*, *F. sporotrichioides* and *Cladosporium epiphyllum*. The morphological and cultural properties of these fungi are described fully. The nature of the toxic reaction induced in animals by the fungi associated with overwintered grain has been studied in detail. It has been concluded that species of *Fusarium*, especially *F. poae* and *F. sporotrichioides*, are the principal agents of septic angina.

INTRODUCTION

In the years 1942–1947, alimentary septic angina, a very serious and in most cases lethal disease, accompanied by necrotic angina, extreme leucopaenia and multiple haemorrhages, occurred widely in the eastern districts of the Soviet Union, especially in the Orenburg district. Occurrence of this disease could be related to the near-famine conditions prevailing in some parts of the Soviet Union at that time. Under these conditions the population was driven to the collection even of grains that had been left in the field and had passed the winter under snow cover, and these grains gave rise to the disease. The source of the specific toxicity of these cereals is one of the basic problems of the disease.

The part played by the fungi in the production of the specific toxin concerned had not been established definitely. Toxic fungi very often present on such cereals had not been studied sufficiently. Moreover, the toxins of the cereals themselves had not been proved to be identical with those of the toxic fungi. And finally, the conditions of toxin formation had been studied only to a small extent.

Received December 18, 1959.

In this paper part of our investigations which corroborate the role of toxic fungi infecting overwintered cereals in the etiology of septic angina, is presented. The work reported here was carried out in the years 1943–1950, while the writer headed the Mycological Division of the Institute of Epidemiology and Microbiology at Orenburg. None of the work has so far been published in the Soviet Union. It was written up for pbulication in 1959, when the writer left the Soviet Union and was later appointed to thestaff of the Department of Botany of the Hebrew University, Jerusalem.

MATERIALS AND METHODS

a) *Origin and Number of Samples*

The material studied consisted of cereal samples which were collected from trial plots after having passed the winter under a cover of snow (Joffe 1950), samples of soils on which the investigated plants had been grown, as wel las overwintered cereals from various areas of the Orenburg district. A considerable number of samples were collected from the population of the district in which cases of septic angina had occurred. As controls served summer-harvested samples collected in the same fields which were later to serve as experimental plots, as well as grain samples from large government storehouses.

The number of samples studied during the years 1943–1944 to 1948–1949 amounted to 768 from overwintered cereals, 244 from summer-harvested cereals, and 189 from the soil.

b) *Methods of Mycological Study*

The grains and vegetative parts of the plants were subjected to macro- and microscopic examination and culturing.

Spores present on the plant surface were studied after centrifugation of the water in which the respective cereal plants had been rinsed.

Under the microscope the centrifugate was found to contain numerous fragments of mycelium and spores of various fungi found in equal abundance on cultures made with the respective grains. It was concluded that numerous spores lose their germination power rapidly and can then not be discovered by culturing. Accordingly all material to be investigated was used immediately upon arrival at the laboratory. The centrifugate often contained spores of *Sorosporium paniciimiliacei*, *Tilletia tritici* and other smuts.

The superficial flora of the grains was studied by culturing on various media. These cultures of non-disinfected grains were overgrown by species of *Penicillium* and *Mucor*. To investigate the internal flora of the grains, these were, therefore, surface-sterilized, and then rinsed and cultured.

The culture media used were Czapek's agar, and agar containing one of the following solutions: carbohydrate-peptone, potato, potato acid and potato dextrose, beer malt, soil solution, clover flowers, oats, barley, beans, alfalfa seed, filter paper wetted with Van Iterson's solution, and also water extracts of ground grains that had passed the winter under snow cover. The *p*H varied from 4.0 to 6.6 depending on medium and material sown: sterile normal millet, millet husks, barley, wheat, rice, potato, sweet-clover aud others.

The toxic samples studied contained no germinating grains, though as a rule germination capacity was found uninpaired, when such grains were laid out to germinate. This fact justified our conclusion that toxicity is associated with conditions unfavourable for grain germination. As the toxic samples had all been collected from grain exposed to the cold of winter and infected by fungi, the suspicion arose that the toxicity of overwintered cereals could have been caused by the development of cryophilous fungi on them (Joffe 1960). To test this possibility, comparative studies were made of the fungi developing on the grain under moderately warm, cold and freezing conditions. The grains in Petri dishes were kept for certainlenths of time at the following temperatures: 20°C, 8°C, 5°C and from + 3°C to −4°C. Subsequently, the number of fungus-infected grains was counted, growth and frequency of specific fungi, and the frequency and prevalence of each species on the grain were determined. Pure fungus cultures mere made from mycelia and from spores found on culture media; in addition, monospore cultures were grown in hanging drops.

For the isolation of fungi from soil various methods were used: 1) Dry sowing for which finely ground soil was spread on the surface of solidified agar in Petri dishes; 2) Vinogradsky's method; 3) spreading of soil suspensions of various dilutions on the surface of solidified agar. Each soil sample was distributed in 16–20 Petri dishes.

Fungi which were found to produce toxins on sterilized millet were invariably found to produce their toxins also on agar or on a liquid medium. Thus, throughout the year of investigations the toxic cultures were grown both on agar and on natural substrates.

c) *Methods of Testing Toxicity*

For this purpose pure fungus cultures were sown on various media of agar and liquid or natural sterilized media (millet, wheat, baley and others), depending on the genus of the fungus.

Our observations had shown that the accumulation of toxin in overwintered cereals increased with sharp temperature fluctuations (Joffe 1950). Therefore, after being grown at temperatures of −5°C to +8°C for 25–70 days, cultures were subjected to successive freezing and thawing. After having their sterility checked, the

cultures were heated in a current steam for 1 hour and were then taken out of their Roux flasks and bottles and were rendered air-dry at a temperature of 40–50°C.

Subsequently, ether or alcohol extractions were made of fungus infected media and the toxicity of the extracts was tested on the skin of rabbits by a special method adapted by the author. Only rabbits with non-pigmented skin and weighing at least 1.5 kg were used. An area measuring 3 × 3 to 4 × 5 cm on each side of the rabbits's body was carefully cleared of hair. Extract contained in a platinum loop measuring 2–3 mm in diameter was applied to the skin of the rabbit twice, with an interval of twenty-four hours. The reaction was recorded for forty-eight hours, but the rabbits were kept under observation for at least six to eight days after the first application. Prior to being subjected to the experimental application, each rabbit was given two control treatments, one with an extract of known toxicity and another with the extract of unaffected grain.

Skin reactions are of two types—leucocytorrhoeic and oedemo-haemorrhagic. The former is characterized by the formation on the skin surface of a whitish, easily detachable film which consists of mass of leucocytes accumulating in the horny layer of the epithelium. The latter type of skin reaction involves an acute oedema and the appearance of haemorrhage and necrotic symptoms; in this case there is no leucocytic film. The estimation of the reaction was based on its principal components—leucocytic film, oedema, haemorrhage, and necrosis.The intensity of necrosis was determined on the eighth day; the other components were recorded on the third day.

The intensity of the leucocytic components was estimated according to the massiveness of the superficial leucocytic film; the intensity of oedema—according to the thickness of the skin fold; the intensity of haemorrhage—by the quantity of visible extravasations; necrosis—by the massiveness of the scab and the time of its shedding. The presence of oedema, haemorrhage and necrosis was regarded as evidence of marked toxicity of the fungus. A pronounced leucocytic film, unaccompanied by any of the other components, was considered as an indication of the toxicity of the experimental material and fungi inducing this reaction were included in the toxic group; a reaction represented by a thin leucocytic film, scattered vesicles, reddening and desquamation, was assessed as weak and doubtful and the associated fungi were termed "mildly toxic".

DEGREE OF INFECTION OF CEREALS BY FUNGI

In order to asses the degree of infection of overwintered cereal crops in 1943, 40 samples of overwintered millet and 20 samples of normal summer-harvested millet (each sample containing 100 – 200 grains) were examined microscopically. All 40 samples of overwintered millet showed fungal infection, 25 of them internally and 15 superficially, whereas no internal infection was detected in any samples of summer-harvested millet, and a superficial infection was recorded only in one out of 20 cases.

In 1944 the following samples of overwintered cereals were examined: 34 of highly toxic millet, 2 of wheat, 2 of rye and 2 of buckwheat. Of the 1590 wintered grains examined 1017, i.e. 60.3%, were found infected. In some of the samples the infection reached 100%. As controls served 15 samples of millet, 3 of rye and 1 of buckwheat. The average infection percentage in grains of overwintered cereal crops was many times higher than in normal summer-harvested crops.

In 1945–49 annual infection percentages of a total of approximately 20,000 grains examined ranged from 20.2 to 27.3 for overwintered wheat, from 14.9 to 23.4 for overwintered millet and from 22.1 to 26.3 for overwintered barley. On summer-harvested grain of the three species only 1.2 to 3.3% of fungi infection was found. On the vegetative parts (the spikes and panicles) of about 7000 inflorescences examined in 1945–49, the respective percentages of infection on overwintered and summer-harvested what were 43.8 and 3.5, on barley 49.6 and 3.7, and on millet panicles 30.2 and 2.2

The difference in infection of summer- as against spring-harvested cereals, as evident from these examinations, indicated the necessity for a thorough study of the mycoflora of cultivated cereals.

THE MYCOFLORA OF OVERWINTERED AND SUMMER-HARVESTED GRAIN

During the period of 1943–1949, 2302 cultures belonging to 39 genera were isolated from overwintered toxic and non-toxic cereals that had been collected in experimental fields, or received from various parts of the district. The isolates from soil samples comprised 720 cultures belonging to 34 genera; and those from samples of normal summer-collected grain. 527 cultures belonging to 11 genera. Thus a total of 3549 cultures of various genera and 192 species were isolated.

The number of genera found on samples of overwintered plants was proportionately much larger than that found on summer-harvested samples. Thus on overwintered cereals representatives of the genera *Trichothecium*, *Macrosporium*, *Hormodendrum*, *Cephalosporium* and others were present, which were not found on control samples of normal summer-harvested cereals. These gehnra, however, were represented only by a small number of isolates, whereas the genera represented by numerous isolates were *Penicillium*, *Fusarium*, *Cladosporium*, *Alternaria* and *Mucor*. On normal samples only the three genera: *Penicillium*, *Mucor* and *Alternaria* were present as a rule, whil e*Fusarium* and *Cladosporium* were found in a few cases only, or were absent altogether.

In summing up one can conclude that the wintering of cereals under snow resulted in the formation of a rich and heterogeneous mycoflora, and in an active increase of fungi of the genera *Penicillium*, *Alternaria*, *Mucor*, *Fusarium* and *Cladosporium*. The degree of infection is much higher in these overwintered cereals than in those normally harvested.

In view of the supposition that the fungi borne on the grain may give rise to disease, each of the fungus isolates was tested for its toxicity. In Table I the fungus species which were isolated and their respective degrees of toxicity are listed.

As evident from the data cited, 185 toxic and highly toxic cultures, and 216 slightly toxic cultures were isolated from overwintered cereals and their soils. No toxic cultures were found on grain or on vegetatiev parts of summer-harvested plants.

Further investigations aimed at assessing the genera most likely to produce toxins. It was assumed that the toxicogenic properties of different genera of fungi might be estimated from the frequency of their occurrence on overwintered cereals, and from the appearance among them of highly toxic strains. From toxic and highly toxic cultures 13 genera were isolated and from mildly toxic 17 genera. The most frequent occurrence of toxic fungi belonged to the genera *Alternaria*, *Mucor*, *Penicillium*, and especially *Fusarium* and *Cladosporium*, each of these begin represented by many species (see Table I). *Fusarium poae* and *F. sporotrichioides*, both of very common occurrence on overwintered cereals in all those parts of the Orenburg district from which material had been collected, were represented in the majority of cultures. Also common were *Cladosporium epiphyllum* and *C. fagi*. Cultures of *Alternaria tenuis*, *Mucor hiemalis*, *M. racemosus*, *Penicillium brevi-compactum*, *P. steckii* and others showed considerable toxicity.

DESCRIPTION OF THE MAIN TOXIC FUNGI

A detailed description of morphological and cultural properties of the most common toxic fungi, *Fusarium poae*, *F. sporotrichioides* and *Cladosporium epiphyllum* is given below.

1. *Fusarium poae* (Peck) Wr. (Figures 1, 4–5).

On potato–agar and on potato–acid–agar, a white, yellow, brown or sometimes pink-coloured aerial mycelium develops. Pseudopionnotes form on the 30th day. Chlamydospores are intercalary and in pale brown chains.

On rice the primary mycelium is yellow, pink and yellow-brown. The rice grains assume a yellow to carmine colour with their margins varying from pink to dark brown and carmine. Secondary mycelium is very weakly developed and white with a delicate tint.

On a potato slice a dirty yellow to pinkish-brown mycelium develops abundantly. The slice margin turns carmine or dark brown.

The microconidia are mostly uni-cellular, roundish to lemon-shaped and pear-shaped. Two-celled conidia are usually ellipsoidal, spindle-shaped and sickle-shaped. Macroconidia sickle-shaped with 3 septa.

Dimensions of conidia are set out on Table II.

The described material was isolated from overwintered cereals and from soil in the Orenburg district, USSR.

TABLE I

Toxicity of fungi isolated from overwintered cereals, summer-harvested cereals and their soils

No. of strain	Name of fungus	No. of isolates from											
		Overwintered cereals								Summer-harvested cereals			
		Grains and vegetative parts				Soils				Grains and vegetative parts			
		Toxic	Mildly toxic	Non-toxic	Total	Toxic	Mildly toxic	Non-toxic	Total	Toxic	Mildly toxic	Non-toxic	Total
	PHYCOMYCETES												
1	*Chaetocladium brefeldii* v. Tiegh. et L.M.		2	3	5		1	2	3				
2	*Chaetocladium* sp.			1	1								
3	*Helicostylum elegans* Cda.			1	1								
4	*Circinella umbellata* v. Tiegh. et L.M.			1	1								
5	*Mortierella candelabrum* v. Tiegh. et L.M.			2	2								
6	*Mortierella capitata* March.							1	1				
7	*Mortierella polycephala* Coemans			1	1								
8	*Mucor albidus* Naum.			8	9								
9	*M. albo-ater* Naum.			15	15		1	8	9				
10	*M. corticola* Hag.	1	1	19	21		1	6	7			8	8
11	*M. dispersus* Hag.		1	8	9			4	4				
12	*M. fumosus* Naum.	1		9	10			6	6				
13	*M. globosus* Naum.	1		21	22		1	7	8				
14	*M. griseo-ochraceus* Naum.		1	5	6			5	5				
15	*M. heterosporus* Fisch.		1	11	12		1	5	6				
16	*M. hiemalis* Wehm.	3	4	34	41		2	13	15			20	20
17	*M. humicola* Raillo	1	1	9	11		1	8	9				
18	*M. murorum* Naum.						1	2	3				
19	*M. oblongisporus* Naum.		1	7	8			4	4				
20	*M. racemosus* Fres.	2	3	33	38		1	20	21			46	46
21	*M. plumbens* Bon.							2	2				
22	*M. sciurinus* Naum.			7	7	1		6	7				
23	*M. silvaticus* Hag.			13	13		1	3	4			16	16
24	*Mucor* sp. No. 1			1	1								
25	*Mucor* sp. No. 2			1	1								

TABLE I
(continued)
Toxicity of fungi isolated from overwintered cereals, summer-harvested cereals and their soils

No. of strain	Name of fungus	No. of isolates from											
		Overwintered cereals								Summer-harvested cereals			
		Grains and vegetative parts				Soils				Grains and vegetative parts			
		Toxic	Mildly toxic	Non-toxic	Total	Toxic	Mildly toxic	Non-toxic	Total	Toxic	Mildly toxic	Non-toxic	Total
26	*Piptocephalis freseniana* D.B. et W.												
	Mucor albo-ater Naum.	1	3	4	8			14	14				
27	*Rhizopus arrhizus* Fisch.			2	2								
28	*R. nigricans* Ehr.	1	2	2	5		1	16	17			54	54
29	*R. nodosus* Namysl.							2	2				
30	*Thamnidium elegans* Link	1	3	33	37			11	11			6	6
31	*Tieghemella turkestanica* Naum.							1	1				
32	*Zygorhynchus moelleri* Vuill.							1	1				
	ASCOMYCETES												
33	*Aspergillus calyptratus* Oud.			1	1								
34	*A. candidus* Link			2	2								
35	*A. flavus* Link			2	2							3	3
36	*A. fumigatus* Fres.		1	4	5								
37	*A. nidulans* (Eidem) Wint.											4	4
38	*A. niger* v. Tiegh.		1	6	7			6	6			14	14
39	*A. ochraceus* Wielh.			2	2								
40	*A. terreus* Thom							1	1			8	8
41	*A. wentii* Wehm.							1	1				
42	*Chaetomium affine* Cda.							1	1				
43	*C. elatum* Kze.			1	1								
44	*C. fimeti* Fuck.							2	2				
45	*C. globosum* Kze.			1	1								
46	*Penicillium albidum* Sopp			5	5		1	10	11				
47	*P. aurantio-virens* Biour.		2	30	32			5	5				
48	*P. biorgeianum* Zal.		1	30	31								
49	*P. brevi-compactum* Dier.	2	1	23	26							5	5
50	*P. canescens* Sopp			12	12		1	9	10				
51	*P. chrysogenum* Thom	1	1	40	42			8	8			7	7

TABLE I

(continued)

Toxicity of fungi isoloted from overwintered cereals, summer-harvested cereals and their soils

No. of strain	Name of fungus	No. of isolates from											
		Overwintered cereals								Summer-harvested cereals			
		Grains and vegetative parts				Soils				Grains and vegetative parts			
		Toxic	Mildly toxic	Non-toxic	Total	Toxic	Mildly toxic	toxic	Total	Toxic	Mildly toxic	Non-toxic	Total
52	*P. citrinum* Thom			9	9							21	21
53	*P. citreo-roseum* Dier.		2	20	22								
54	*P. corymbifer* Westl.			15	15			4	4			14	14
55	*P. corylophilium* Dier.			6	6			8	8				
56	*P. crustosum* Thom		1	43	44			17	17			12	12
57	*P. cyaneo-fulvum* Biour.		1	6	7								
58	*P. cyclopium* Westl.	1	1	24	26			3	3				
59	*P. fellutanum* Biour.			4	4							11	11
60	*P. griseo-roseum* Dier.		1	33	34			9	9				
61	*P. howardii* Thom		1	9	10		1	11	12				
62	*P. jenseni* Zal.			7	7	1		12	13				
63	*P. lagerheimi* Westl.			5	5							16	16
64	*P. martensii* Biour.		2	15	17			3	3				
65	*P. meleagrinum* Biour.			5	5			14	14				
66	*P. melinii* Thom			8	8			11	11				
67	*P. miczynskii* Zal.		2	17	19								
68	*P. namyslowskii* Zal.			30	30								
69	*P. nigricans* Bain.	2	2	34	38	1	1	11	13				
70	*P. notatum* Westl.	1	2	23	26			7	7			19	19
71	*P. oxalicum* Cur. et Thom			8	8			12	12			31	31
72	*P. palitans* Westl.		1	11	12								
73	*P. purpurogenum* Fler.-Stoll		1	17	18			3	3				19
74	*P. restrictum* Gilm. et A.			11	11		1	8	9			17	17
75	*P. rubrum* Stoll			4	4							13	13
76	*P. steckii* Zal.	2	1	11	14			7	7				
77	*P. tardum* Thom			6	6			1	1			11	11
78	*P. umbonatum* Sopp	1	1	25	27			4	4				
79	*P. viridicatum* Westl.	1	1	27	29		1	4	5				
80	*P. waksmani* Zal.			10	10			2	2				

TABLE I
(continued)
Toxicity of fungi isolated from overwintered cereals, summer-harvested cereals and their soils

No. of strain	Name of fungus	No. of isolates f om											
		Overwintered cereals								Summer-harvested cereals			
		Grains and vegetative parts				Soils				Grains and vegetative parts			
		Toxic	Mildly toxic	Non-toxic	Total	Toxic	Mildly toxic	Non-toxic	Total	Toxic	Mildly toxic	Non-toxic	Total
81	*P. westlingi* Zal.		1	18	19			1	1				
82	*Pleospora infectoria* Fuck.			2	2								
83	*P. vulgaris* Nies.			1	1								
84	*Sclerotinia libertiana* Fuck.			4	4			3	3				
85	*Sclerotinia* sp.			1	1			1	1				
	FUNGI IMPERFECTI												
	SPHAEROPSIDAE												
86	*Phoma* sp. No. 1			3	3								
87	*Phoma* sp. No. 2							2	2				
88	*Phoma* sp. No. 3							1	1				
89	*Rhabdospora* sp.			1	1								
90	*Septoria* sp. No. 1			1	1								
91	*Septoria* sp. No. 2			1	1								
	HYPHOMYCETES												
92	*Acremoniella verrucosa* Togn.			1	1								
93	*Acrostalagmus albus* Preuss			2	2								
94	*A. cinnabarinus* Cda.			1	1			2	2				
95	*Acrostalagmus* sp.							1	1				
96	*Alternaria humicola* Oud.	2	4	40	46			9	9			3	3
97	*A. brassicae* Sacc.							3	3				
98	*A. oleracea* Milb.							3	3				
99	*A. tenuis* Nees.	10	21	350	381	2	2	58	62			81	81
100	*Alternaria* sp. No. 1			1	1								
101	*Alternaria* sp. No. 2							1	1				
102	*Botrytis cinerea* Pers.		1	1	2								
103	*B. fulva* Link			1	1								

TABLE I

(continued)

Toxicity of fungi isolated from overwintered cereals, summer-harvested cereals and their soils

No. of	Name of fungus	No. of isolates from											
		Overwintered cereals								Summer-harvested cereals			
		Grains and vegetative parts				Soils				Grains and vegetative parts			
		Toxic	Mildly toxic	Non-toxic	Total	Toxic	Mildly toxic	Non-toxic	Total	Toxic	Mildly toxic	Non-toxic	Total
104	*B. pilulifera* Sacc.							1	1				
105	*Cephalosporium acremonium* Cda.			5	5			2	2				
106	*C. humicola* Oud.			2	2			3	3				
107	*C. charticola* Lind.							1	1				
108	*C. coremioides* Raillo							3	3				
109	*C. roseum* Oud.							1	1				
110	*Cephalothecium roseum* Cda.							2	2				
111	*Cladosporium elegantulum* Pidopl.			1	1								
112	*C. epiphyllum* (Pers.) Mart.	8	11	73	92	2	2	25	29			2	2
113	*C. exoasci* Link	2		15	17			3	3			1	1
114	*C. fagi* Oud.	4	1	28	33			9	9				
115	*C. fuligineum* Bon.	1	1	17	19			6	6				
116	*C. gracile* Cda.	3		19	22			4	4				
117	*C. graminum* Cda.		2	11	13			6	6			2	2
118	*C. grumosum* (Pers.) Link		2	22	24			3	3				
119	*C. herbarum* (Pers.) Link	2	12	35	49		1	24	25			11	11
120	*C. molle* Cke.	2		29	31			2	2				
121	*C. penicillioides* Preuss	1	4	36	41		1	5	6			2	2
122	*C. pisi* Cug. et March.		4	14	18			8	8				
123	*C. spherospermum* Penz.	1		9	10			5	5				
124	*Cladosporium* sp. No. 1			1	1								
125	*Cladosporium* sp. No. 2			1	1								
126	*Coremium glaucum* Link	1			1								
127	*Fusarium arthrosporioides* Sherb.		1	7	8			2	2			5	5
128	*F. avenaceum* (Fr.) Sacc.	2	1	15	18			4	4				
129	*F. bulbigenum* Cke. et Moss.			7	7								
130	*F. culmorum* (W.G.Sm.) Sacc.	2	1	13	16								
131	*F. diversisporum* Sherb.		1	3	4								
132	*F. equiseti* (Cda.) Sacc.	4	1	19	24			6	6			18	18

TABLE I
(continued)

Toxicity of fungi isolated from overwintered cereals, summer-harvested cereals and their soils

No. of strain	Name of fungus	No. of isolates from											
		Overwintered cereals								Summer-harvested cereals			
		Grains and vegetative parts				Soils				Grains and vegetative parts			
		Toxic	Mildly toxic	Non-toxic	Total	Toxic	Mildly toxic	Non-toxic	Total	Toxic	Mildly toxic	Non-toxic	Total
133	*F. graminearum* Schw.		1	2	3								
134	*F. graminum* Cda.	1	2	11	14			6	6			3	3
135	*F. javanicum* Koord.			8	8							5	5
136	*F. kühni* (Fuck.) Sacc.		1	9	10								
137	*F. lateritium* Nees	2	2	24	28		1	3	4				
138	*F. martii* App. et Wr.			5	5								
139	*F. moniliforme* Sheld.	1	3	22	26		1	10	11				
140	*F. nivale* (Fr.) Ces.		2	11	13								
141	*F. orthoceras* App. et Wr.		1	7	8							2	2
142	*F. oxysporum* Schl.	1	1	2	4		1	13	14				
143	*F. poae* (Pk.) Wr.	44	17	2	63	2	3		5				
144	*F. redolens* Wr. Wr.	1		5	6			2	2				
145	*F. sambucinum* Fuck.	1	1	14	16								
146	*F. scirpi* Lamp. et Fautr.	2	2	17	21		1	3	4			9	9
147	*F. scirpi* Lamp. et Fautr. v. *acuminatum* (Ell. et Ev.) Wr.	1		5	6								
148	*F. semitectum* Berk. et Rav.	2	1	20	23								
149	*F. solani* (Mart.) App. et Wr.		3	11	14			5	5				
150	*F. sporotrichioides* Sherb.	42	15	4	61	2	2		4			2	2
151	*F. tricinctum* (Cda.) Sacc.	2	1	19	22			5	5				
152	*Gliocladium fimbriatum* Gilm. et Abb.							1	1				
153	*G. penicillioides* Cda.		1	1	2								
154	*Gliocladium* sp.							1	1				
155	*Gonatobotrys flava* Bon.		3	5	8								
156	*Helminthosporium gramineum* Rabenh.			1	1			2	2				
157	*H. sativum* Pk. et B.			2	2								
158	*Helminthosporium* sp.			1	1								
159	*Hormodendrum hordei* Bruhne			4	4			1	1				
160	*H. nigrescens* Paine			1	1			2	2				

TABLE I

(continued)

Toxicity of fungi isolated from overwintered cereals, summer-harvested cereals and their soils

No. of strain	Name of fungus	No. of isolates from											
		Overwintered cereals								Summer-harvested cereals			
		Grains and vegetative parts				Soils				Grains and vegetative parts			
		Toxic	Mildly toxic	Non-toxic	Total	Toxic	Mildly toxic	Non-toxic	Total	Toxic	Mildly toxic	Non-toxic	Total
161	*H. viride* (Fres.) Sacc.							3	3				
162	*Macrosporium commune* Rabenh.		1	3	4								
163	*M. bifurcum* (Fres.) Sacc.							1	1				
164	*Macrosporium* sp.			2	2								
165	*Monotospora brevis* (Gilm. et Abb.) Mas.							1	1				
166	*Spicaria divaricata* Thom.							1	1				
167	*S. violaceae* Abb.			1	1								
168	*Stemphylium botryosum* Wallr.							1	1				
169	*S. verruculosum* Zimm.			4	4			1	1				
170	*Stysanus stemonitis* Cda.			2	2								
171	*Stysanus* sp.							1	1				
172	*Tilachlidium humicola* Oud.			1	1			1	1				
173	*Torula convoluta* Harz							1	1				
174	*T. lucifusa* Oud.							1	1				
175	*Torula* sp.			1	1								
176	*Trichoderma album* Preuss							1	1				
177	*T. koningi* Oud.							2	2				
178	*T. lignorum* Tode (Harz)	1		18	19			10	10			2	2
179	*Trichoderma* sp.							1	1				
180	*Trichothecium roseum* Link	2	3	26	31	1		5	6				
181	*Verticillium album* Riv.			2	2							4	4
182	*V. lateritium* Rabenh.	1	1	8	10								
183	*Verticillium* sp.							1	1				
184	*Zygodesmus fuscus* Cda.			1	1			1	1				
	MYCELIA STERILIA												
185	*Rhizoctonia aderholdi* (Ruhl.) Naum.							2	2				
186	*Sclerotium* sp. No. 1			1	1								
187	*Sclerotium* sp. No. 2			1	1								

TABLE I
(continued)
Toxicity of fungi isolated from overwintered cereals, summer-harvested cereals and their soils

No. of strain	Name of fungus	No. of isolates from											
		Overwintered cereals								Summer-harvested cereals			
		Grains and vegetative parts				Soils				Grains and vegetative parts			
		Toxic	Mildly toxic	Non-toxic	Total	Toxic	Mildly toxic	Non-toxic	Total	Toxic	Mildly toxic	Non-toxic	Total
	ACTINOMYCETES												
188	*Actinomyces cylindrosporus* Kras.							9	9				
189	*A. globisporus* Kras.						1	12	13				
190	*A. griseus* Kr.					1		10	11				
191	*Actinomyces* sp. No. 1							1	1				
192	*Actinomyces* sp. No. 2							1	1				
	Total	172	182	1948	2302	13	34	673	720			527	527

TABLE II

Conidial dimensions in Fusarium poae
(Measurements made on acid potato agar)

Shape of conidia	Average dimensions (μ)	Usual range observed (μ)
Non-septate pear or lemon-shaped	7.8×5.2	4.8— 9 ×4.5—6.2
Non-septate spindle-shaped	10.7×3	10— 15×2.6—4.2
1-septate pear- or lemon-shaped	12.8×5.6	10— 18×3.8—5.6
1-septate spindle-shaped	19 ×3.5	12—25.6×2.6— 5
3-septate sickle-shaped	26.7×4	18.6— 35×3.5—5.2

TABLE III

Conidial dimensions in Fusarium sporotrichioides
(Measurements made on acid potato agar)

Shape of conidia	Average dimensions (μ)	Usual range observed (μ)
Non-septate pear-shaped	10.2× 4	6—12×2 — 7
Non-septate ellipsoidal	10.2× 5.2	5—11×4 — 8
1-septate pear-shaped	16 × 9	11—19×4.2— 7
1-septate ellipsoidal	13 × 6.2	9—20×4 — 8
Non-septate elongate or sickle-shaped	10.5× 2.5	8—15×2 — 3
Non-septate spindle-shaped	12 × 2.8	9 —16×2.5—3.8
1-septate elongate or sickle-shaped	17 × 3.2	15 —21×3 —3.5
1-septate spindle-shaped	18 × 3.1	15.5—26×2.6—4.2
3-septate sickle-shaped or spindle-shaped	28 × 2.8	25 --33×2.6—4.2
4-septate sickle-shaped or spindle-shaped	33 × 4	30 —40×3.5—4.4
5-septate sickle-shaped or spindle-shaped	45 × 3.8	38 —48×3.8—4.5 less frequently 41 —56×3.5—4.2

2. *Fusarium sporotrichioides* Sherb. (Figures 2, 6 – 7)

Cultures on potato-agar and potato-acid-agar have a well developed aerial mycelium which is white with a pink or carmine hue; pseudopionnotes form on the 15–30th day. Chlamydospores are mostly intercalary, uni-cellular, arranged in chains, colourless, light-brown or sometimes pink, with a rough or smooth surface.

On rice aerial primary mycelium is yellow or brown. Rice grains assume an olive-brown, pink or carmine colour of various shades. The grain margin turns dark brown, sometimes yellow-brown. The weakly developed secondary mycelium is white with a yellow-brown tinge. Sclerotia are oval or round, brown.

On a potato slice the aerial mycelium is light yellow to brown, growing luxuriantly and spreading all over the test tube. The potato slice turns brown at its margin.

The morphology of conidia was studied on potato-agar. Microconidia are borne on conidiophores or scattered on the mycelium; they are spherical, pear-shaped, ellipsoidal, uni-cellular, non-septate (Table III). The described material was isolated from overwintered cereals and from soil (in rare cases from summer-harvested wheat) in the Orenburg district, USSR.

3. *Cladosporium epiphyllum* (Pers.) Mart. (Figure 3).

Colonies on Czapek's agar have a fine velvety texture and dark olive colour, or are densely felty, roughly warted, and olive-grey; the growing mycelium has a light-coloured edge. Colonies on carbohydrate-peptone agar are dark green or brown; at an early stage they are usually non-coalescent and velvety; later often coalescing and forming an uninterrupted velvety dark brown layer. Colonies are even and velvety up to 1 mm above the substrate.

The aerial mycelium is colourless, pale olive, up to 3μ in diameter, forming chains or irregular colonies when older; chlamydospore cells are thick-walled with dense content and pale olive or brown in colour. The substrate mycelium branches reticulately, is dusky olive in colour, up to 4μ in diameter and contains oil drops.

Conidiophores are dusky olive, turning brown with age; they are straight or curved, branch articulately, are minutely septate and have dimensions of 75–250 × 4–6 μ.

Conidia are numerous, arranged in loose panicles and dendroid formations, smooth, at first uni-cellular, later 2–3–5-celled; they are light brown in colour, smooth and ovoid, oblong, cylindrical or bluntly ellipsoidal. Their size varies largely with their shape: smallest ones lemon-shaped, non-septate conidia 2 – 4 × 3 – 6μ; ovoid non-septate conidia 4 – 6 × 3–4μ; oblong 1 – 4-septate conidia 9 – 21 × 3 – 5.5μ; cylindrical 1 – 4-septate conidia 7 – 12 × 3 – 4μ; bluntly ellipsoidal 1 – 2- septate conidia 9 – 22 × 4 – 6 μ. (All measurements made on Czapek agar).

Spores germinate after 6 – 12 hours, the germ-tube reaching a length of 110 μ after 24 hours and developing well at 2 – 23°C. The gelatine liquifies slowly and in part

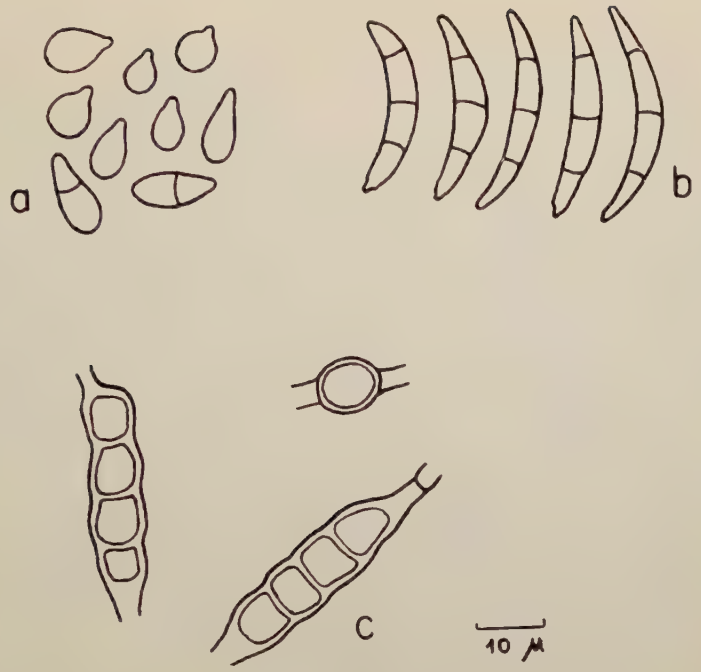

Figure 1.
Fusarium poae: a) microconidia; b) macroconidia; c) intercalary chlamydospores

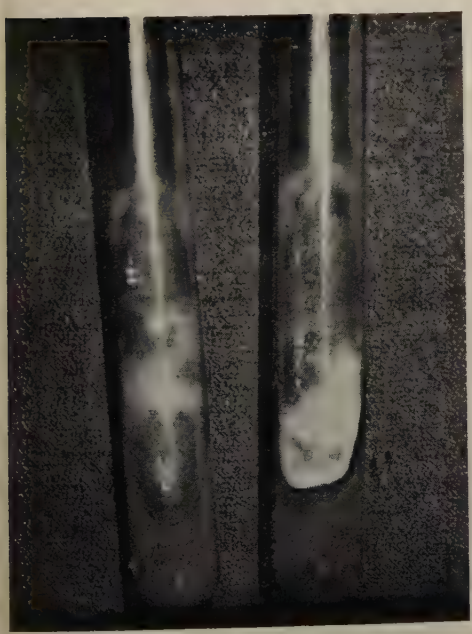

Figure 4

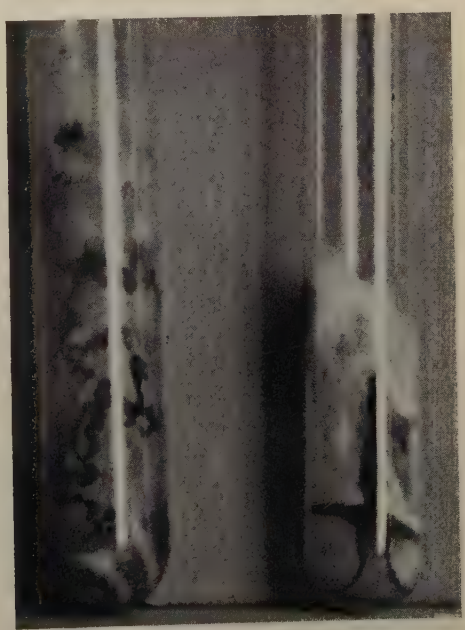

Figure 5

Fusarium poae on potato agar (Figure 4), on rice (Figure 5).

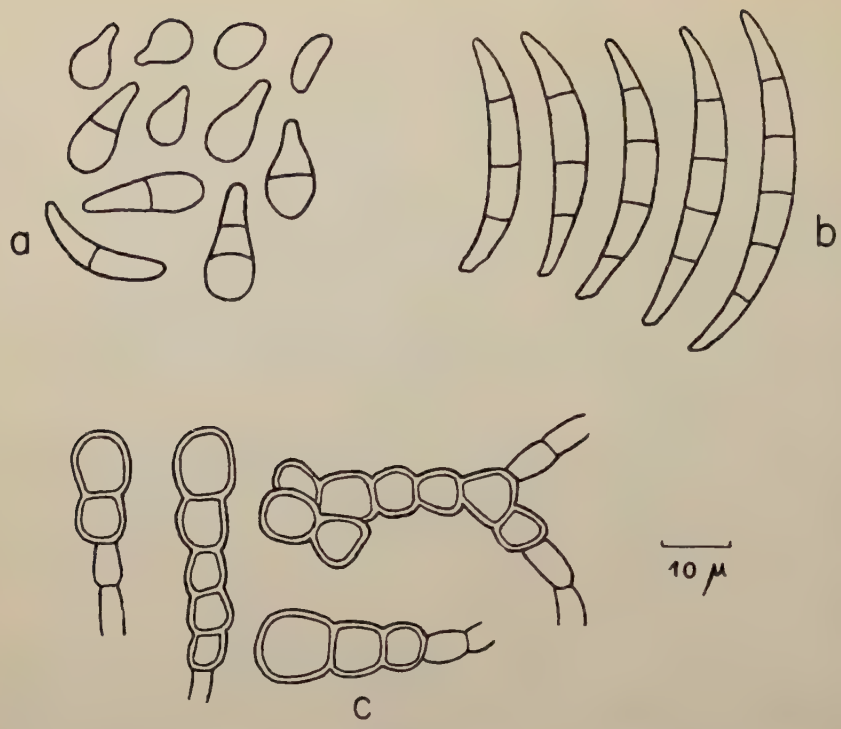

Figure 2.
F. sporotrichioides: a) microconidia; b) macroconidia; c) intercalary chlamydospores

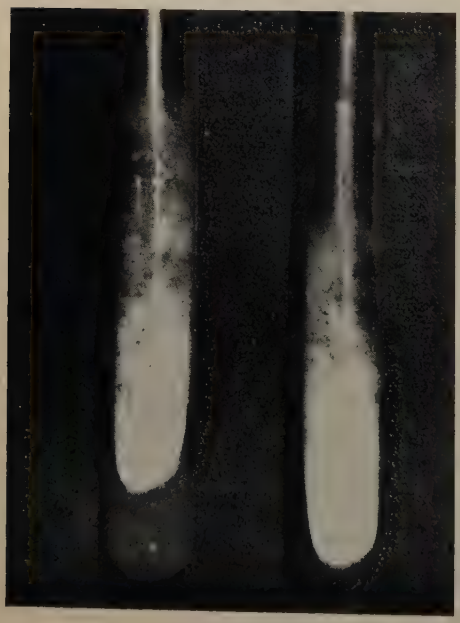

Figure 6

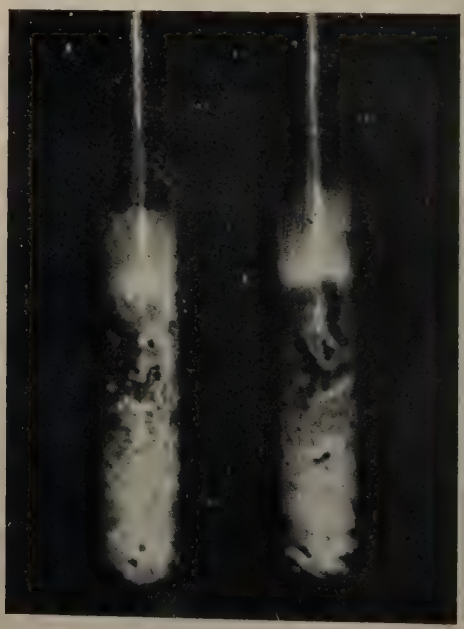

Figure 7

Fusarium sporotrichioides on potato agar (Figure 6), on rice (Figure 7).

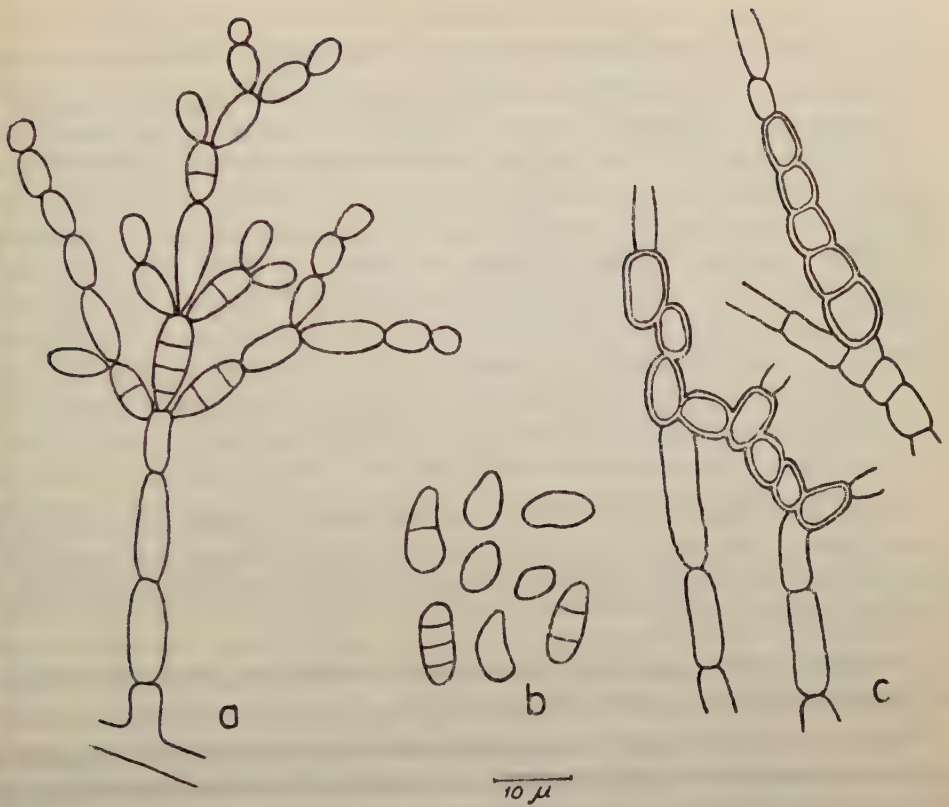

Figure 3.

Cladosporium epiphillum a) conidiophore and conidia; b) conidia; c) chlamydospores

only. The material decribed was isolated from grain and vegetative parts of over-wintered cereals (wheat, millet, barley), and from soils in the Orenburg district, U.S.S.R.

TOXIC EFFECTS ON TEST ANIMALS

The toxic effect of fungi associated with feeding-stuff is usually appraised by feeding experiments (Miessner and Schoop 1929, Christensen and Kernkampf 1936). Such experiments were also carried out by us, but they were supplemented by a newly developed method of skin tests, which has been fully described above. Here the type of reaction produced, whether leucocytorrhoea, oedema, or haemorrhage, and the severity of each of these phenomena, was used as criterion to assess the toxicity of each isolate.

a) *Skin Reactions*

The percentage of toxic cultures isolated in each of five genera is shown in Table IV.

TABLE IV

Toxicity of the main fungus genera infecting overwintered cereals and their soils

Genus	Total No. of cultures	Toxic cultures		Highly toxic cultures	
		No.	% of total No.	No.	% of total No.
Fusarium	501	179	35.6	112	22.4
Cladosporium	480	67	14.0	26	5.4
Alternaria	506	41	8.1	14	2.8
Penicillium	830	45	5.4	13	1.6
Mucor	335	34	10.1	10	3.0

As seen from Table IV over 35% of isolated *Fusarium* cultures were toxic to a certain degree, and over 22% cultures were highly toxic. Highly and moderately toxic cultures were much less common in *Cladosporium*, and still less so in *Mucor*, *Alternaria* and *Penicillium*.

The genera *Fusarium*, and in the second place *Cladosporium*, were represented in the largest number in the toxic cultures isolated.

As mentioned before, mildly toxic cultures of the fungi listed in Table I produced no haemorrhage on the skin of rabbits, but caused an inflammatory reaction on the spot of application with a subsequent reddening of the skin and the appearance of a slight leucocytorrhoea, with or without a slight oedema of the skin.

Of the toxic fungi listed in Table I. those of the genera *Cladosporium*, *Alternaria*, *Mucor*, *Penicillum* caused a mainly leucocytorrhoeic reaction, sometimes accompanied by a heavy oedema. Only one culture of *Cladosporium fagi*, No. 35, caused haemorrhage, while one culture of *Alternaria tenuis*, No. 1286, and one of *Mucor corticola*, No. 876, gave rise to an oedemo-haemorrhage reaction. Cultures of *Fusarium* generally caused an oedemo-haemorrhage reaction followed by heavy necrosis.

Some of the *Fusarium* cultures produced a purely leucocytorrhoeic or oedemo-leucocytorrhoeic reaction (Joffe and Mironov 1947, Joffe 1960). Quite often rabbits perished following application of *Fusarium* extracts.

It was interesting to compare toxicity of cultures with the toxicity of the cereal samples, from which they had been isolated. Highly and mildly toxic fungi were detected in 1945—49, both on toxic and on non-toxic overwintered cereals, whereas in 1944, when septic angina was widely occurring in the Orenburg district, mildly and highly toxic cultures were isolated mostly from toxic samples of overwintered cereals.

On comparing the type of reaction obtained from highly toxic fungi with that obtained from the respective cereal samples from which they had been isolated (samples gathered in spring 1944), it was noteworthy that toxic *Cladosporium* cultures producing a reaction of the leucocytorrhoeic-oedematic type and *Fusarium* cultures giving an oedematic-haemorrhagic reaction had been isolated solely from highly toxic cereal samples. Thus it is most probable that the decisive part in developing toxicity in overwintered cereals was played by those *Fusarium* and *Cladosporium* species which gave the above-mentioned types of reaction.

Strukov and Mironov (1947) studied the histology of the skin to which several toxic fungi from our material had been applied. The fungi belonged to the genera *Mucor*, *Penicillium*, *Cladosporium*, *Thamnidium*, *Trichothecium* and some others. He indicated that changes in tissue which developed following an application of ether extracts of these fungi to the skin of rabbits were similar to reactions caused by extracts from toxic millet. The most typical leucocytorrhoeic reaction was produced by *Cladosporium epiphyllum*, which has often been found on overwintered millet.

Mayasnikow (1948) who isolated *Fusarium poae* in our laboratory found that its toxic principle was analogous with that contained in overwintered cereals. Similar results were obtained from our material by Olifson (1956) who studied the chemical composition of millet after its being experimentally infected with pure cultures of *Fusarium poae* and *F. sporotrichioides*. He also determined the chemical structure of the products of their metabolism.

It is evident from what has been said so far that the genera *Fusarium* and *Cladosporium* and others which frequently recurred in our material, were considerably varied in their species composition. Moreover, the examined cereals usually were contaminated simultaenously by several different species or genera of toxic fungi. This fact complicates the problem of the specific toxicity of wintered cereals and forces us to the assumption that in the formation of toxins several species of fungi act simultaneously. In other words, the etiologic factor of septic angina is a mycocoenose. However, evidence of these chemical properties and of their toxic effect on animals, makes us conclude that *Fusarium* (especially *F. poae* and *F. sporotrichioides*) is the main agent in the etiology of this disease (Joffe 1960).

As we have stated elsewhere (Joffe 1960), toxic species of *Fusarium* always produced strong toxicity when inoculated on sterilized grain. As regards toxic species of *Cladosporium*, *Mucor*, *Alternaria* and *Penicillium*, their inoculation on sterilized millet also produced toxicity but not always of a strong nature. A comparison between the toxicity of overwintered cereals and that of fungi isolated from them disclosed that toxic fungi developed in many cases also on non-toxic samples of cereals.

b) *Feeding Experiments*

In order to establish the part played by toxic fungi on winter exposed grain in the etiology of septic angina, the investigation was directed to the fungis general toxic

effects on animals, and feeding experiments were made with pure cultures of the toxic species of *Fusarium*, *Cladosporium*, *Mucor*, *Alternaria* and *Penicillium*. Mice, guinea-pigs, rabbits, cats and horses were included in these tests.

The general toxic action of *Fusarium poae*, *F. sporotrichioides* and others has been described in a separate paper dealing with the toxicity and antibiotic properties of several Fusaria (Joffe 1960). Here we are only concerned with the results of experiments on the respective toxicity of the species of *Cladosporium*, *Mucor*, *Alternaria* and *Penicillium* on animals.

Sterilized millet grain, agar and liquid media were seperately infected with various toxic fungi. The cultures were grown at different temperatures with alternating freezing and thawing. The toxic properties of *Cladosporium epiphyllum* and *C. fagi* were tested in experiments on mice.

Mice perished within 2–18 days of being fed *per os* on agar or millet cultures of *Cladosporium epiphyllum*, *C. fagi* and their extracts, or on dry fungus mass, as well as on liquid media. Intracutaneous injections of the fungus filtrate caused death of mice within 24–48 hours. Feeding with *Cladosporium epiphyllum* and *C. fagi* led to the death of mice accompanied by symptoms of reduction of the leucocyte content in blood and hyperemia of intestines and other organs. It should be added that *Fusarium* had an even stronger general toxic effect on mice.

Experiments were carried out on guinea-pigs and rabbits by feeding them on dry fungal mass and on liquid media of the following toxic fungi: *Cladosporium epiphyllum*, *C. fagi*, *C. gracile*, *C. fuligineum*, *Penicillium steckii*, *P. crustosum*, *P. notatum*, *P. jenseni*, *P. brevi-compactum*, *Alternaria tenuis*, *Mucor hiemalis*, *M. racemosus*, *M. albo-alter* + *Piptocephalis frenseniana* and *M. corticola*.

Guinea-pigs fed on *Alternaria tenuis*, *C. epiphyllum*, *C. gracile*, *Penicillium steckii*, *P. brevi-compactum*, *M. albo-ater* + *Piptocephalis freseniana* and *M. hiemalis* perished on the 6–28th day. They showed the same serious symptoms whether they were fed on dry fungus or on liquid substrate. When *Penicillium crustosum*, *P. notatum*, *P. jensenii*, *Cladosporium fagi*, *Mucor racemosus* and *M. corticola* were used for feeding, the symptoms appeared somewhat later, and the animals perished on the 14 – 30th day.

Rabbits fed on toxic *Penicillium notatum*, *P. jensenii*, *Mucor hiemalis*, *Cladosporium epiphyllum*, *C. fagi* and *C. fuligineum*, died on the 10–33th day, or on the 13–36th day when fed on *P. brevi-compactum*, *P. steckii*, *Cladosporium gracile*, *Mucor albo-ater* + *Piptocephalis freseniana*, However those which received *M. corticola* or *Penicillium crustosum* stayed alive. Guinea pigs and rabbits which were given toxic cultures of *Cladosporium*, suffered from leucopenia and from slight leucocytosis, whereas two rabbits showed no change whatsoever in their blood picture. Feeding animals experimentally with *Mucor*, *Alternaria* and *Penicillium* caused leucocytosis and in some cases leucopenia.

After autopsy, haemorrhages in organs especially in the intestine walls were noted in almost all tested animals.

The effects of *Cladosporium epiphyllum*, *C. fagi*, *C. fuligineum*, *C. gracile* and *C. penicillioides* on cats were also investigated. The species *C. epiphyllum*, *C. gracile* and *C. penicillioides* were especially toxic after being grown on sterile millet. Cats showed a decline in numbers of leucocytes and perished on the 7–19th day. Pathologic-anatomical investigations showed hyperemia of the intestines and kidneys, as well as a flabbiness of the adrenals. *C. fagi* and *C. fuligineum* had a less marked toxic effect on cats. While cats fed on sugar cultures of *C. gracile* and *C. penicillioides* perished on the 13–26th day, those fed on *C. fagi*, *C. fuligineum* and *C. epiphyllum* remained alive and were dicarded after 35 days.

So far we have described feeding experiments with cultures of individual fungi only. But in nature toxic fungi appear in mixtures of various species. We now proceeded to test such mixtures. For this purpose we used a mixture *Cladosporium epiphyllum*, *Mucor hiemalis*, *Alternaria tenuis* and *Penicillium steckii*. To this mixture the following *Fusarium* species—all of which had previously been shown toxic to guinea-pigs and rabbits (Joffe 1960)—were added singly: *F. poae*, *F. sporotrichioides*, *F. lateritium*, *F. tricinctum*, *F. semitectum*, *F. equiseti* and *F. sambucinum*. These mixtures were tested on 28 cats and 170 mice.

The mixtures were administered either as a dry fungal mass, or in the form of millet which had been infected by a suspension prepared from the mixed cultures. In all the cats tested leucopenia was recorded, and they all perished within 4–42 days. Autopsy revealed symptoms resembling those of alimentary-toxic angina in humans. In mice general toxic symptoms were noted along with a considerable fall in the blood's leucocyte content, leucopenia, hyperemia of the digestive tract and of other organs. All mice perished within 2–19 days.

These results show that mixtures of the above fungi can be highly toxic and support the assumption that they may well act together in the mycocoenose causing septic angina.

A very thorough experiment was carried out by feeding *Cladosporium epiphyllum* to a horse (Antonov, Belkin, Joffe, and others 1951). During four days 270 gr of culture were fed to the horse, but had no constant toxic effect. The morphological blood picture disclosed lymphocytosis. The number of erythrocytes and leucocytes fluctuated up and down as compared to normal. The toxin was excreted by the horse and its presence in the faeces and urine was revealed by an application of extracts of these excretions to the skin of a rabbit.

It is noteworthy that the media on which toxic cultures of *Alternaria tenuis*, *Penicillium steckii* and *Mucor hiemalis* were grown as well as alcohol extracts of these fungi's mycelium had a toxic effect also on *Paramaecium caudatum* (Drabkin and Joffe 1952).

To determine the part the fungi play in the etiology of alimentary toxic angina, we compared the changes effected by their toxin in the animal organism with those brought about by the toxin of overwintered cereals. As shown elsewhere (Joffe 1960), extracts from cultures of *Fusarium poae* and *F. sporotrichioides* isolated from both millet and agar media had a general toxic effect with a skin reaction of the necrotic type on mice and cats, similar to that produced by extracts of overwintered cereals. The animal died of hyperemia of the digestive tract and other organs, as well as of haemorrhages and drastic changes in the adrenals. Millet and agar cultures of *Cladosporium epiphyllum* fed to mice, rabbits and guinea-pigs as a dry fungal mass or its filtrate produced a general toxic effect of the leucocytorrhoeic type, again similar to that produced by extracts of overwintered cereals. Animals that were fed on the fungi and on toxic winter exposed cereals showed a marked decline in the leucocyte content of their blood. Also there was a frequent appearance of leucopenia the degree and duration of which fluctuated with the concentration of the toxin, the dose applied and the individual peculiarities of the animals. Thus by these experiments on animals our assumption was confirmed that the toxic characters of overwintered cereals are connected with the action of a complex of fungi, rather than of one individual fungus.

DISCUSSION

In the United States and in Europe toxic effects have variously been noted after fungus infected grain was fed to various livestock, especially pigs. Such effects were prominent when barley affected severely by scab (*Gibberella saubinetii* or its conidial stage *Fusarium roseum*) was used for feeding (Popp 1930, Striulciuc 1930). Vomiting was induced by this Fusarium in pigs (Christensen and Kernkamp 1936). Dickson (1956) states that "the growth of *Gibberella* and *Fusarium* spp. in the developing (wheat) kernel results in the formation of compounds that act as strong emetics in man, pigs, dogs and animals with similar digestive systems". He also mentions that one of the symptoms of poisoning produced by these fungi is a temporary irritation and soreness of the stomach and intestinal membranes.

The toxic reactions produced on our test animals after feeding on cultures of *Fusarium poae* and *F. sporotrichioides* and cereals infected with these fungi, were very much stronger and in the majority of cases even lethal. The symptoms produced in the intestines were far from temporary, but were profound necrosis, haemorrhages, etc. The toxicity of our fungi was also much in evidence in the skin tests carried out on rabbits.

As regards toxic reactions produced by other fungi associated with feeding stuff, mention has been made of the presence of *Cladosporium herbarum* and of species of *Alternaria* on barley that proved poisonous to pigs (Miessner and Schoop 1929), but the toxicity of these species has not actually been proved. We have found pronounced toxicity, both in feeding experiments and in skin tests, in various species

of *Cladosporium* and *Alternaria*, especially in *C. epiphyllum* and *A. tenuis*. Moreover, a number of species of *Mucor* and *Penicillium* also exhibited strong toxic properties.

CONCLUSIONS

The inference from the evidence presented is that the development of toxic fungi on cereals occurs only when they pass the winter under snow cover. In many cases toxic fungi were isolated also from non-toxic or mildly-toxic overwintered cereals. This fact proves that some auxiliary factors are at play, regulating the process of toxin formation.

The largest number of toxic fungi were found in the genera *Fusarium*, *Cladosporium*, and a somewhat smaller number in *Alternaria*, *Mucor* and *Penicillium*. The most frequently found were *Fusarium poae* and *F. sporotrichioides*, followed by *Cladosporium epiphyllum*.

Thus the toxic *Fusarium poae*, *F. sporotrichioides*, *Cladosporium epiphyllum* and some others can bring about the accumulation of toxic substances in cereals exposed to winter conditions.

Skin reactions caused by these fungi resembled the changes found after application to rabbits of extracts from overwintered cereals.

Introduction of these substances into the organism of animals (mice, cats, rabbits, guinea pigs) led mainly to disturbances in blood production; extreme leucopenia developed along with lymphocytosis, and a decline of the erythrocyte and haemoglobin content. Apart from this there was a rise in permeability of the intestine walls which was evident from the appearance of haemorrhages in mucus membranes.

Mixed cultures of toxic *Cladosporium epiphyllum*, *Mucor hiemalis*, *Alternaria tenuis*, *Penicillium steckii* combined with toxic cultures of *Fusarium poae*, *F. sporotrichioides*, *F. lateritium*, *F. tricinctum*, *F. sambucinum*, *F. semitectum* and *F. equiseti* were toxic in their effects on cats and mice. Autopsy of test animals (mainly of cats) revealed changes similar to the syndrome of alimentary toxic angina in humans.

Normal grain infected by *Fusarium poae*, *F. sporotrichioides*, *Cladosporium epiphyllum* and others, acquires toxic properties.

The toxicity of the overwintered cereals was usually determined by a complex of several different species or genera of toxic fungi, i.e. by a mycocoenose.

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A STUDY OF LICHENS OF THE NEGEV

MARGALITH GALUN* AND I. REICHERT

Faculty of Agriculture, The Hebrew University, Rehovot and Agricultural Research Station, Rehovot

ABSTRACT

Thirty seven lichen species and varieties, collected in the Negev, were determined. Seven of them are new species. The geographical distribution of these lichens is given.

INTRODUCTION

The lichen flora of Israel, especially of its southern part—the Negev—has not hitherto been the subject of a comprehensive taxonomic investigation.

The first contribution on lichens of this region was published by Mueller Argo (1880). It contains a list of some lichens common in the Negev area. Since that time only a few lichens of the Negev have been studied from the phytogeographical and taxonomical point of view by Reichert (1937a,b, 1940).

In the following an attempt has been made to determine a collection of lichens containing 37 specimens from the Negev area. Seven of these lichens are described as new species.

PHYSIOGRAPHICAL DATA

The climate, soils and vegetation of the region under review are described in short in the following.

The region referred to in this work may be defined as that part of the country which is situated southerly to a line passing through Nirim, Beersheva and Ein-Gedi.

Climate. The annual rainfall (Manne and Rosenan 1957) in the area comprising the loess steppes east and south-east of Beersheba fluctuates between 150 – 200 mm. This amount decreases to 100 – 150 mm in the northern part of the Negev — the Irano-Turanian steppes — and in the Saharo–Sindian deserts southerly to Beersheva; in Mt. Ramon and the remaining areas of the Negev there is a further decrease in the amount of rainfall, which falls to 30 – 40 mm in the steppes and hammada deserts of the southeastern Negev. The year-to-year fluctuations in the amount of rainfall are considerable.

The differences in day and night and winter and summer temperatures are higher in this region than in other parts of the country. The average annual temperature

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in the region under survey is approximately 20°C and fluctuates between 24–32°C (average daily temperature) in the hottest month of the year and between 8–14°C in the coldest one. The average difference in temperature between day and night is 12–14°C (Rosenan 1957).

Soils. There are five different soil types in the region under survey. Loess in the area east to Beersheva. Hammada hills with loess interspersed in depressions in the southwestern part. Calcareous rocks in the central and southern part — with loess again dominating in the depressions. To the east of the latter we find an area of rugged hammada deserts. The southeastern Negev consists of unfertile hammada plains. The southwestern part of the Negev, which comprises mainly sand dunes, is not included in this work — as no lichens have been found there. We may conclude therefore, that the part of the Negev, with which this study deals, consists mainly of bare rocky highlands and loess valleys and depressions, whereas the soils contribute but little to the Negev lichen flora and no lichens were found in the sand dunes.

Vegetation. The vegetation has been described in detail by Zohary (1955,1957). The Negev comprises parts of two phytogeographical territories of Israel — the Irano-Turanian and the Saharo–Sindian. In each of them several plant associations encountered.

The typical plants of the main associations of the Irano-Turanian territory are *Achillea santolina* and *Artemisia herba alba;* those of the Saharo-Sindian territory are *Zygophyllum dumosum*, *Haloxylon articulatum* in the rocky areas, and *Anabasis articulata*, *Acacia tortilis*, *Artemisia monosperma* in the valleys, depressions and sandy soils.

METHODS

The material described was examined under the magnification of a binocular lens at 12×. Anatomical structure was studied on hand-cut sections under the magnification of 400×. Single organs and cells were measured under 1000× magnification. All the measurements were taken from sections stained with cotton-blue.

The designation of colours given here in quotation marks is according to Ridgway (1912).

PYRENOCARPEAE

Fam. *DERMATOCARPACEAE*

Dermatocarpon (Sect. *Endopyrenium*) *hepaticum* (Ach.) Th.Fr.f. *nigratum* (Muell. Arg.) Zahlbr.

Zahlbr. in Cat. Lich. univers. 1: 217. 1922. — *D. hepaticum* Th. Fr. in Nova Acta reg. Soc. Sci. upsal. 3 Ser. 3: 355. 1861. — *Endocarpon hepaticum* Ach. in Kgl. Vetensk. – Akad. Nya Handl.: 156. 1809. — *Endopyrenium hepaticum* f. *nigratum* Muell. Arg. in Rev. Mycol. 6: 14. 1884.
N: On soil in fissures of the ruins of Shivta, 10.9.1955 *EG.**

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* ABBREVIATIONS. *Districts:* AV = Arava Valley; D = environs of the Dead Sea; JD = Judaean Desert; N = Negev.
Collectors: *B* = H. Breuer; *EG* = E. Galun; *MG* = M. Galun; *G* = J. Gutter; *H* = J. Halprin; *K* = B. Komarovsky; *ML* = M. Litvak; *L* = J. Lorch; *N* = M. Negbi; *R* = I. Reichert; *Z* = D. Zohary.

Distribution

Mueller Argo (1884) collected this lichen for the first time in Jericho and Beitin ("Beth El") and described it as *Endopyrenium hepaticum* f. *nigratum*. Lamb (1936) mentions this form from the Bahrein Island.

The examination of a specimen described by Flagey as *Peltula radicata* Nyl. (Lichenes Algerienses, Exs. No. 211) and collected by him in Biskara, where it grew on soil in fissures of calcareous rocks, revealed its identity with the specimens described by Lamb from the Bahrein Island and with the specimens from the Negev.

Dermatocarpon (Sect. *Endopyrenium*) *convexum* I. Reichert et M. Galun sp. nov. Figure 1.

Thallus indeterminatus, squamulosus, ater, squamulis minutis, ± orbicularibus et convexis, fissuris separatis. Hypothallus tenuissimus, squamulosus, ater. Perithecia immersa, solitaria vel dua triave, apice prominente. Excipulum pallidum vel fuscescens, ostiolum obscure fuscum vel atrum. Sporae octonae, ellipsoideae.

Thallus forming irregular patches if 3–10 mm in diam., squamulose, squamules 0.5–1 mm wide and 150–500μ thick (thickest near the apothecia), ± orbicular and convex, separated by thin fissures, blackish, getting dark brown and swollen when moistened. Hypothallus squamulose and thin. Upper cortex 30–40μ, paraplectenchymatous, cells thin-walled, 3–7.5μ in diam., exterior 15–20 μ, dark brown, no or a thin (12μ) yellowish-brown amorphous stratum. Gonidia 3–9μ, stratum ca. 60μ, dense and continuous, distinctly limited upwards, indistinctly limited downwards. Medulla loosely cellular, cells rounded and thin-walled, translucid, partly also with lax hyphae. Lower side dark brown but not distinctly corticated. Root-like hyphae penetrating the substratum.

Perithecia 250–400μ in diam., globose, immersed one or sometimes two in one squamule, apex slightly prominent, dark brown. Excipulum pale to pale brown, upper part (40–50μ) dark brown to black, densely cellular, cells 7–8μ×1.5–2μ. Spores hyaline, ellipsoid, with 1–2 vacuoles (or oil drops), 10.5–13.5×6–7.5μ, 8 spores in one row in each ascus, asci numerous, no paraphyses to be seen among them.

N: On calcareous rocks at the top of Maaleh Haakrabim and on its western slope,6. 1949 *L.*

Our species is characterized mainly by its convex nearly swollen squamules. It resembles mostly *D. insulare* Mig. Both species form irregular patches built of 4–6 (10) convex squamules. In our species the squamules are small and black on both sides, getting brown only when moistened, whereas *D. insulare* has larger squamules and is chestnut-brown on the upper side.

GYMNOCARPEAE

Fam. *COLLEMACEAE*

Collema tenax (Sw.) Ach. emend Deg. var. *vulgare* (Schaer.) Deg. f. *nudum* Deg. Deg. in Symb. bot. upsal. 13(2): 163. 1954. — *Collema tenax* Ach. in Lichenogr. univers. : 635. 1810. — *C. pulposum α vulgare* Schaerer, Enum. crit. Lich. eur.: 259. 1850. — *Lichen tenax* Swartz in Nova Acta reg. Soc. Sci. upsal. 4: 249. 1784.

N: On plaster and soil in the fissures of the ruins of Shivta, mainly on the northern shadowy sides, 10.9.1955 *EG*, 14.12.1956 *MG*.

Distribution

Var. *vulgare* grows, according to Degelius (1954), especially on soil of exposed walls, ruins, in small fissures of natural rocks, etc. Var. *vulgare* is widely distributed and common in the south of Europe. From the Mediterranean area, where it is the dominant type, it extends with decreasing frequency to the southern parts of Scandinavia. On Oeland and Gotland it is the dominant variety.

Typical samples, especially of f. *vulgare* (f. *nudum*), have been seen by Degelius from Asia and North Africa (Morocco, Algeria, Egypt).

Fam. *PYRENOPSIDACEAE*

Psorotichia numidella Foress.

Forss. in Nova Acta reg. Soc. Sci. upsal. 3 Ser. 13: 76. 1885.

D: On dolomite, betw. Ein Bokek and Massada, 13.11.1957 *MG*. AV: On crystalline limestone, Beer Menuha, 6.1949 *L*.

By reexamining the specimen identified by Flagey as *P. numidella* Forss. (Lichenes Algerienses, Exs. No. 301) we could confirm, what has already been noticed by Harmand (1905), that this specimen is not *P. numidella*, but *P. ocellata*, because it has a green epithecium (the epithecium of *P. numidella* is yellow). We found another proof that Flagey's specimen does not belong to *P. numidella*. The hymenium gives a yellow reaction with I–I K, which is characteristic for *P. ocellata*, whereas *P. numidella* reacts blue with I–IK.

It might be important to emphasize here the basic difference between the two types of epithecium in both species. The green epithecium of *P. ocellata* is a continuous gelatinous stratum, whereas the epithecium of *P. numidella* is composed of small yellow granules covering the apices of the paraphyses.

Fam. *DIPLOSCHISTACEAE*

Diploschistes steppicus I. Reichert

I. Reichert in Palest. J. Bot. Rehovot 3: 173. 1940.

N: On calcareous soil and loess, 25 km ESE of Dimona, near the Dimona-Sodom road, 10.4. 1957 *H*; near Ovdat, 28.3.1945 *Z*; 43 km SSE of Beersheva. 17.3.1947 *G*; Great Canyon, 12. 11.1957 *MG*.

Distribution

D. *steppicus* has been found, according to Reichert (1940), in Israel, Syria, Transjordan, Iraq, Persia and Southeastern Transcaucasia, always closely associated with the Irano-Turanian steppe vegetation.

Diploschistes tenuis I. Reichert et M. Galun sp. nov. Figure 2

Thallus crustaceus, laevis, areolatus – rimosus, KOH—, subalbidus. Apothecia solitaria, immersa, minute, disco nigro, plano; excipulum parte interna hyalina, parte externa nigra; apothecia matura margine thallino evanescente. Hymenium

hyalinum. Hypothecium tenue, hyalinum. Sporae octonae, muriformae, fuscae. Paraphyses hyalinae, rectae.

Thallus crustaceous, even, separated by very thin cracks into ± regularly sized (0.5–2mm), plane, ca. 1 mm thick, whitish ("Tilluel Buff") areolae. Cortex 28–35μ thick, opaque from numerous granules, some medullarian hyphae penetrating the cortex, KOH – . Gonidial stratum 80–120μ, interrupted by strands of medullarian hyphae. Medulla hyphose, quite grey from the interspersed small granules, hyphae intricate, very thin (0.5–1μ), KOH – , some gonidia dispersed among them.

Apothecia single, immersed, max. 1000μ in diam., disc black, plane; excipulum 60–70μ thick, interior part built of hyaline 1.5μ thick hyphae, exterior part built of black 2.5–3μ thick hyphae; proper margin 80 – 120μ high and 80μ wide, formed by the continuation of the black exterior part, brush-like at the top; thalline margin covering the hymenium of the young apothecia, disappearing in mature apothecia. Hymenium 240–280μ high, hyaline. Hypothecium thin, ca. 15μ, hyaline. Spores muriform, thin-walled, with rounded ends, young spores hyaline getting brown with maturity, mature spores measuring 28–32×14–17μ, with 5–7cross walls and 1–4 longitudinal walls traversing all cells except the one at each end which mostly remains aseptate, 8 spores ± in one row in each ascus, shrivelling after leaving the asci. Paraphyses hyaline, straight, unbranched, 140×1.5μ.

N: On calcareous stones, Mamshit (Kurnub), 17.3. 1947 *G*; "White Rock Hills" in the Beersheva-Og'a Road (opposite Revivim and Mashabei Sadeh), 12.11.1957 *MG*.

This new species is characterized by its deeply immersed apothecia, which can be distinguished only as small, blackish pores.

Fam. *ACAROSPORACEAE*

Acarospora reagens A. Zahlbr. f. *radicans* (Nyl.) H. Magn.

H. Magn. in Kungl. svensk. Vetensk. – Akad. Handl. 4: 272. 1929. — *A. reagens* A. Zahlbr. in Cat. Lich. univers. 5: 85. 1929. — *Lecanora schleicheri dealbata* f. *radicans* Nyl. Lich. in Aegypto a Ehrenb. coll.: 63. 1864. — *Placodium radicans* Muell. Arg. Lich. de Palestine: 13. 1884.

JD: On soil, betw. Jericho and Jerusalem, 1.4.1932 *R*.N: near Ovdat, 28.3.1945 *Z*; Great Canyon, 12.11.1957 *MG*.

Distribution

A. reagens f. *radicans* was found for the first time by Ehrenberg near Bir-Haman in Egypt, and was described by Nylander (1864) as *Lecanora schleicheri dealbata* f. *radicans*. Mueller Argo (1884) collected and described this lichen from the Judaean desert.

Magnusson (1929) when describing *A. reagens* says that the medulla is 200μ thick or more. In our material the medulla measures 600μ and sometimes even more. We cannot know what Magnusson meant by "...or more", but by substracting the gonidial stratum (70–170μ) + the cortex (30–50μ) + the amorphous stratum (10–40μ)

from the general thickness of the thallus (500–700μ) one gets more than 200μ (Measurements quoted from Magnusson).

We noticed in our material some more deviations from Magnusson's data: 1) The amorphous stratum quoted by Magnusson as 10–40μ thick, is in our material 45–80μ. 2) According to Magnusson no excipulum or a very thin (10μ) one exists. In our specimens we could clearly see an excipulum on the sides of the hymenium, which was 15–20μ thick.

Acarospora areolata I. Reichert et M. Galun sp. nov. Figure 3

Thallus areolatus, areolis dispersis vel maculas minutas formantibus; areolae pruinosae, albo-cinereae, leviter convexae, adnatae, subtus pallidae. Apothecia numerosa, solitaria vel pauca, leviter immersa, disco atro, plano, margine thallino thallo concolori; excipulum crassum. Hymenium hyalinum, iodo caerulescens. Hypothecium hyalinum. Sporae numerosae, minutae, cylindricae.

Thallus uncontinuous, areolate; areolae (0.5)–1–2.5 mm wide and 0.4–0.8mm thick, dispersed, single or in small groups, greyish-white, pruinose, slightly convex, surface roughly granulated, the larger areoles sometimes with thin splits, lower side pale, attached to the substratum. Cortex ca. 30μ, translucid, reticulate, hyphae 3–5μ thick; exterior 15μ, brown amorphous stratum (pruina) 10–20μ. Gonidial stratum 150–300μ, interrupted by medullarian hyphae perpendicular to the surface. Medulla greyish, opaque from masses of particles of the substratum. No lower cortex.

Apothecia numerous, orbicular or shapeless, single or 2–3 in one areola, immersed, at an equal level with the thallus. Disc 0.5–1.5 mm in diam., black, plane, thalline margin concolorous with the thallus. Excipulum at the base 15–40μ broad, widened to 150μ toward the surface. Hymenium hyaline, 100–150μ high, I–IK + blue. Hypothecium hyaline, 70–90μ high, grumose. Epithecium yellowish-brown, 10–15μ thick. Paraphyses unbranched, septate, apices yellowish-brown, slightly swollen, 1.5–3μ thick, conglutinate. Spores ca. 100 in each ascus, 4.5–6$\times$1.5–2μ, cylindrical.

N: On calcareous stones, near the peak of Mt. Ramon, 29.4.1957 *EG*.

This lichen resembles two species: *A. bicolor* Wain. known from the Transcaspian region and *A. cervina* Mass. common in the north and south of the Mediterranean and in Asia. The structural differences between our lichen and those mentioned justify its description as a new species: 1) The spores of *A. bicolor* are ellipsoid or subglobose and 3μ broad, whereas the spores of our new species are cylindrical and 1.5–2μ broad. 2) The hymenium of *A. bicolor* is 85–100μ high whereas the hymenium of our species is 100–150μ.

3) The excipulum of our species is broad, up to 150μ in its upper part and the excipulum of *A. cervina* is indistinct or only 5–10μ broad. 4) Our species has no lower cortex, whereas *A. cervina* has a 16–30μ thick lower cortex.

Fam. *LECANORACEAE*

Lecanora crenulata (Dicks.) Hook.

Hook. apud Sm. Engl. Flora, 5: 194. 1844 — *Lichen crenulatus* Dicks. Fasc. Plant. cryptog. Brit. Plants, 2: 709. 1776.

N: On dolomitic grindstone, Shivta, 14.12.1955 *MG*; on calcareous stones, 5 km SE. of Dimona, near Sdeh Boker, 14.4.1959 *MG*.

A special noticeable feature of this species is the regularly incised thalline margin, which is in our specimens much more regular than in specimens of Borrer's Herbarium, England, kept in the Smithsonian Institution, National Museum, Washington.

Lecanora (*Aspicilia*) *farinosa* Nyl.

Nyl. in Bull. Soc. Linn. Normand. 2 Ser. 6: 307. 1872 and Lich. Envir. Paris: 66. 1896.

N: On ± chalky × flinty limestone, Bir Hafir, 3.5.1929 *R*; on limestones, Mamshit (Kurnub), 43 km S. of Beersheva, near the Beersheva-Nitzana road, s. d. *G*; "White Rock Hills", s. d. *MG*; 5 km SE. of Dimona, near Sdeh Boker, 14.4.1959 *MG*.

Distribution

L. farinosa is widely distributed in the south and north of the Mediterranean, and is known also from Iraq and Egypt. According to the various collectors the lichen is common on limestone and usually associated with *Caloplaca aurantia* var. *aurantia*, which is true for L. *farinosa* in the Negev too

Lecanora (*Aspicilia*) *hoffmannii* Muell. Arg.

Muell. Arg. in Flora, 72: 511. 1889.

N: On flint, Bir Hafir, 3.5.1929 *R*; near Mamshit (Kurnub), 4 km from the starting point of the Petroleum " Road", 5.6. 1949 *L*; 2 km S. of Rosh Zohar, 10.9.1955 *EG*;; "White Rock Hills", 12.11.1957 *MG*; 5 km SE. of Dimona near the Dimona-Sodom Road, 14.4.1959 *MG*

Distribution

The specimens from the Negev are identical with Flagey's *Lecanora calcarea* var. *hoffmannii* (Lichenes Algerienses Exs. No. 245) collected by him in Constantine: "sur les rognous siliceus, enchansses dans les grands calcaires de l'hospital de Constantine".

It is worthwhile to mention that *L. hoffmannii* is widely distributed on flinty substrate in the Negev and is one of the characteristic types of the "flint lichens association". Other localities where *L. hoffmannii* has been collected are: Greece (Steiner 1898), near Teheran (Wainio 1904), near Alexandria (Mueller Argo 1880), Hoggar-Sahara (Faurel, Ozenda, and Schotter 1953), Czecheslovakia (Servit 1929), Central Asia (Magnusson 1940).

Lecanora negevensis I. Reichert et M. Galun sp. nov. Figure 4

Thallus cinerascens, centro areolatus, ambitu lobatus, areolis minutis et convexis, lobis brevibus, leviter convexis et incisis, KOH + lutescens, $CaOCl_2$ + rubescens, KOH + CaOl + rubescens. Apothecia numerosa, sessilia, disco nigro, pruinoso, margine thallino thallo concolori, excipulum tenue, hyalinum. Hymenium iodo caerulescens. Hypothecium hyalinum. Epithecium brunneo-nigrum. Paraphyses apice capitatae. Sporae octonae, ellipsoideae.

Thallus greyish, orbicular, 1–3 cm in diam., 900–1200μ thick, centre areolate, periphery lobate, areolae ± convex, irregular in form and size, lobes ± convex,

slightly incised, 1–1.5mm long and 1–2mm wide, the region behind the lobes is covered with black cilia, KOH + yellow, $CaOCl_2$ + purple, KOH + CaOCl + purple. Cortex 220–320μ, built of hyphae and many minute granules, exterior layer 60–65μ thick, gelatinous – to be seen mainly in the lobate region, KOH + yellowish, CaOCl + purple. Gonidial layer interrupted and indistinctly limited. Medulla hyphose, hyphae 1–1.5μ thick, loosely interwoven, upper part of the medulla brown from many small granules and substrate particles. Apothecia numerous, sessile, 500–1300μ in diam., disc black getting brown when moistened, mature apothecia pruinose, thalline margin concolorous with the thallus (disappearing in mature apothecia), built of a brown ca. 50μ thick hyphose cortex, hyphae perpendicular to the surface, 1.5 μ thick, among the hyphae are some small granules, gonidial stratum of the cortex 40–50μ thick. Thalline margin 30–35μ high. Excipulum 15μ, built of hyaline hyphae continuous from the hypothecium. Hymenium 80–115μ high, blue with I – IK. Epithecium 15μ, dark brown-black. Hypothecium built of very thin, hyaline, very loosely interwoven hyphae, 160–200μ high, beneath the hypothecium several groups of gonidia are dispersed. Paraphyses 70–1.5μ, unbranched, upper cell ± globular (3–3.5μ) and dark brown-black. Spores simple, hyaline, ellipsoid, with several vacuoles, 7.5–8.5×3.5μ in size, 8 spores in each ascus, asci 38–42×11–12μ in size. Conidia hyaline, curved, 14–20×1μ.

On lithographic stone, Mamshit (Kurnub), 17.3.1947 *G*.

L. negevensis resembles *L. alphoplaca* mainly by its macroscopical features, but is distinctly separated from it by: 1) The different KOH reaction of the thallus, which is yellow in our species and blood red in *alphoplaca*. 2) The smaller spores, 7.5–8.5×3.5μ versus 11–13×7.5–8μ in *alphoplaca*. 3) The size and form of the conidia, which are covered and 14–20μ long in our species, whereas in *alphoplaca* they are cylindrical and 6–7μ long.

Lecanora crassa (Huds.) Ach.

Ach. in Lichenogr. univers. : 413. 1810. — *Lichen crassus* Huds. in Flora anglica, 2 ed. 2: 530. 1778.

JD: Betw. Jericho and Jerusalem, 25.12.1930 *R*.

N: On loess or on calcareous soil, near Ovdat, 28.3.1930 *Z*.

Distribution

L. crassa is a common lichen in the Mediterranean area, from where it extends to the xerothermic region of Central Europe, the Alpine valleys as well as the eastern and western borders of the Alps. According to Faurel, Ozenda and Schotter (1953) it has been found in El-Kantara of the Algerian Sahara too.

Lecanora lentigera Ach.

Ach. in Lichenogr. univers. : 423. 1810.

JD: 12 km E. of Jerusalem, s. d. *K*. N: On loess, Bir Hafir, 3.5. 1929 *R*; 22 km S. of Beersheva, (beyond Wadi Aroer), 17.3. 1947 *G*; several localities along the "Petroleum Road", 6.1949 *L*; Wadi Mura, 25 km ESE. of the Dimona road, 10.4.1957 *M*; Great Canyon, 12.11. 1957 *MG*; near Sdeh Boker, 14.4. 1959 *MG*; near Ovdat, 28.3.1945 *D*.

Distribution

L. lentigera is widely distributed and common in the steppic areas in various parts of the world.

L. lentigera has been found according to Suza (1937), in the Mediterranean region from the Iberian Peninsula to Iraq; in the arid region of southern Russia up to Central Asia; from Lake Aral and the Caspian Sea to Irkutsk. From the Mediterranean region it extends northwards to the southern part of England, the central part of Scandinavia and to the Baltic Islands Oeland, Gotland and Oesel. Then it penetrates deeply through the Alpine valleys and follows the eastern and western borders of the Alps to the north. It occurs also in the Rhine valley, central Germany and Bohemia. *L. lentigera* has been found according to Fink (1935), in Nevada, Nebraska Colorado and Montana. However Poelt (1958) in his monograph of the foliacious *Lecanora* species, says that from North America he has met this lichen only from the Rocky Mountains — a finding which we think still needs clarification.

Candelariella minuta I. Reichert et M. Galun sp. nov. Figure 5.

Thallus crustaceus, cinerascens, orbicularis vel inter alios lichenes invadens, tenuis, areolatus, areolae cum basi plana et margine prominente, KOH–. Apothecia numerosa, sessilia, disco plano vel leviter concavo, margine thallino crasso et prominente, integro vel crenato. Hymenium hyalinum, superne cum strato granulari brunneo. Hypothecium pseudoparenchymaticum. Paraphyses rectae, septatae, apice incrassatae. Sporae octonae, simplices, ellipsoideae.

A very small lichen, forming roundish patches or intermingled with other lichens. Thallus greyish, KOH–, thin, areolate, areolae very small with a plane base and prominent margin, arranged in ± parallel rows.

Apothecia numerous, sessile, max. 500μ in diam., roundish or shapeless, KOH–, disc plane or ± concave ("Citrine"), surrounded by a prominent, entire thalline margin, getting incised in mature apothecia; margin paler than the disc ("Aniline Yellow"), 80–120μ thick, composed mainly of gonidia, surrounded by a hyaline, thin (10–12μ) cortex of roundish cells (3–6μ); cortex covered with a thin granular layer — the continuation of the pseudoepithecium. Hymenium hyaline, 70–90μ, blue with I-IK. Epithecium 6–8μ, brown, granulated. Hypothecium 75–95μ, hyaline, pseudoparenchymatous, funnel-shaped, beneath a continuous gonidial layer. Excipulum 8–15μ, hyphose, hyphae straight, long-celled (6–12μ) and thin (2.5–3μ), in the upper part cells getting shorter and slightly rounded. Paraphyses septate, unbranched, 1.5–2μ thick gradually widened toward the apex up to 3.5μ. Spores hyaline, ellipsoid or bean-shaped, with both ends rounded or one end pointed, simple, with vacuoles or oil drops, 12–18×4.5–6μ.

N: On dolomite, Tel el Milek, 14.3.1956 *MG*; Shivta, 14.1.1956 *MG*; on limestone near Dimona and Sdeh Boker, 14.4.1959 *MG*.

Hakulinen, the monographer of the genus *Candelariella*, examined a specimen from our material and identified it as *C. medians* A.L. Smith. *C. minuta* is perhaps most closely related with *C. medians*, but we think it deserves to be described as a new species on account of the following differences:

1) *C. medians* has a yellowish (flavo-vitellinus) thallus and *C. minuta* a greyish one. 2) *C. minuta* is not lobate in the periphery. 3) The thallus is not granular as in

C.medians, but areolate. 4) The thallus is small 1.5–2cm, whereas the thallus of *C. medians* is 4–5 cm in diam. 5) The apothecia are rare in *C. medians* and numerous in our species.

Fam. *CALOPLACAEAE*

Blastenia rejec a Th. Fr. var. *bicolor* (Muell. Arg.) A. Zahlbr.

A. Zahlbr. in Cat. Lich. univers. 7: 41. 1931. — *B. rejecta* Th. Fr. Lichenogr. scandin. 1: 396. 1874. — *B. melanocarpa* var. *bicolor* Muell. Arg. in Rev. Mycol. 2: 78 1880.

N: On calcareous stones, Ma'aleh Ha'akrabim (near Wadi Fukra), 24.3.1947 *G*; Great Canyon, 12.11.1957 *MG*

Distribution

Schweinfurth collected in 1877–79 some very closely related specimens in the deserts of Egypt (in Wadi Cherese and Wadi Naumia). Mueller Argo (1880) described them as *Blastenia melanocarpa* and three varieties: *bicolor*, *leucoloma* and *versicolor*. Our specimens belong to var. *bicolor* on account of the brownish margin of the apothecia.

Caloplaca aegyptiaca (Muell. Arg.) Stnr. var. *circinans* Stnr.

Stnr. in Ann. naturh. Staatsmus. 34: 55. 1921 — *C. aegyptiaca* Stnr. in Ann. Mycol. 8: 238. 1910. — *Callopisma aegyptiaca* Muell. Arg. in Rev. Mycol. 2: 37. 1880.

N: On greyish limestone, Mamshit (Kurnub), 17.3.1947 *G*; on crystalline, greyish dolomite, Tel el Milek, 14.3. 1956 *MG*; on limestone, Mizpeh Ramon, 14.4.1959 *MG*.

Distribution

Steiner (1921) says in his description that *C. aegyptica* var. *circinans* has a clear prothallus and that the thallus colour changes toward the periphery. We examined Steiner's original material No. 331 (kept in the Naturhistorisches Museum), which was collected by Handel-Mazzetti (1910) in Syria near Kabaris between Aleppo and the Euphrates river, but could not notice these two features in this specimen. Neither did we find these characters in our specimens from the Negev. However, Steiner may have seen them in the other specimens — No. 3344 from Djebel Sindshar, No. 1234 from Mosul and No. 1896 from Tass Karab above Urfa — named by him *C. aegyptiaca* var. *circinans* and also collected by Handel — Mazzetti.

Caloplaca interveniens (Muell. Arg.) A. Zahlbr.

A. Zahlbr. in Cat. Lich. univers. 7: 146. 1931. — *Callopisma interveniens* Muell. Arg. in Rev. Mycol. 6: 17. 1884.

N: On limestone, near Dimona, 14.4.1959 *MG*; On crystalline greyish dolomite, Tel el Milek, 14.3.1956 *MG*.

Distribution

This lichen is known so far only from one locality. It was collected in Egypt and described by Mueller Argo (1884) as *Callopisma interveniens*.

Caloplaca luteo-alba Th. Fr.

Th. Fr. in Nova Acta reg. Soc. Sci. upsal. 3 Ser. 3: 120. 1861. — *Gyalolechia luteo-alba* Arn. in Flora 67: 257. 1884.
On *Acacia tortilis*.

There are many lichens closely related to *C. luteo-alba*, among them lignicolous, saxicolous and terricolous types. Geographically they are distributed in the most different regions of the world. Zahlbruckner (1928, 1931) caused a great confusion in the taxonomy of these lichens by referring to them once as *Caloplaca pyracea* Th. Fr. and once as *Candelariella luteo-alba*, Lett.

We described our specimens as *C. luteo-alba*, because they resemble mostly *Lecanora luteo-alba* (= *Caloplaca luteo-alba*) described by Harmand (1913).

Caloplaca pyrithrella (Nyl.) Oliv.

Oliv. in Bull. Soc. intern. Geogr. bot. 10: 40. 1910. — *Lacenora pyrithrella* Nyl. in Bull. Soc. Linn. Normand. 2 Ser. 6: 260. 1872. — *Lecidea pyrithrella* Hue in Nouv. Archiv. du Mus. 5 Ser. 3: 158. 1913.

N: On dolomite betw. Tel Arad and Rosh Zohar. 14.3.1956 *MG*; on limestone, near Dimona, 14.4.1959 *MG*.

Distribution

The structure of the specimens from the Negev agrees with Hue's (1913) description of *C. pyrithrella* based on two specimens from Europe, one from the Pyrenean mountains and the other from Switzerland: "in valle de Bagnes."

Caloplaca flageyana (Flag.) A. Zahlbr.

A. Zahlbr. in Cat. Lich. univers. 7: 130. 1931. — *Gyalolechia cinnabarina* Flag. in Rev. Mycol. 17: 104. 1895.

N: On greyish dolomite, betw. Tel Arad and Rosh Zohar, 14.3.1956 *MG*; Great Canyon, 5 km SE. of Dimona, near Sdeh Boker, 14.4.1959 *MG*; on limestone, Great Canyon, "White Rock Hills", 12.11.1957 *MG*.

Distribution

Ain-Tinn (Algeria) is the only locality where this species is known from.

This species was first described by Flagey (1896) as *Gyalolechia cinnabarina*, afterwards the name was changed by Zahlbruckner (1931) to *Caloplaca flageyana*, because there exists already a species *C. cinnabarina* (Ach.) A. Zahlbr.

We had great difficulties with the identification of this lichen, because Flagey in his description determines the colour of the thallus as "jaune chamois" and Harmand (1913) as "ochracé pale". But while examining Flagey's original (Lichenes Algerienses, Exs. No. 225) it became clear that the colour mentioned by the above authors is the colour of the substrate and not of the thallus. The small thallus residues are greyish as in our material.

C. flageyana and *C. pyrithrella* look very much alike. They differ in the colour of the disc, which is "orange rufous" in *C. flageyana* and "chestnut" in *C. pyrithrella*, and in the form of the spores, which have a broad isthmus in *C. pyrithrella* and a thin one or no isthmus in *C. flageyana*.

Caloplaca negevensis I. Reichert et M. Galun sp. nov. Figure 6

Thallus areolatus, areolae minutae, dispersae vel contiguae, centro concavo, cinereo et pruinoso, margine inciso et sorediose cincto, KOH + purpurascens. Cortex paraplectenchymaticus. Hypothallus tenuis, arenaceus. Apothecia rara, minutissima, disco plano, margine thallino evanescente vel granuloso, fere biatorino. Hymenium et hypothecium hyalina. Paraphyses septatae, apice incrassatae. Sporea octonae, hyalinae, placodiomorphae.

Thallus areolate, areolae 0.5–1mm in diam., dispersed or several crowded upon a very thin sand-coloured hypothallus, central part depressed-concave, greyish, pruinose, circumference lobate, lobes becoming sorediose with age. Soredia between capitiform and labriform; thallus lemon-green ("olive lake"), KOH + purple 310–350μ thick, amorphous stratum yellowish, beneath a 8–20(–40)μ layer of compressed colourless cells. Cortex paraplectenchymatous, originated from short-celled hyphae perpendicular to the surface (after Maas Geesteranus), clumps of gonidia penetrating the cortex; medulla obscured by granules and crystals, hyphae ca. 3μ thick; no lower cortex.

Apothecia rare, 250–300μ in diam., disc plane, orange coloured, surrounded by a somewhat paler thalline margin, disappearing or changing into small granules with maturity, margin nearly biotorine (the gonidial layer beneath the hypothecium usually not reaching the hymenium), 20–52μ thick, pseudoparenchymatous, exterior part amorphous, translucid after heating. Hymenium hyaline, 60μ high. Hypothecium hyaline, 30–40μ high, built of very densely interwoven hyphae. Paraphyses septate, 48–50 × 1–1.5μ, apices 4.5μ thick, sometimes branched at the upper part. Spores hyaline, placodiomorph, 7 × 12μ.

On a piece of pottery, Rosh-Zohar, 19.9.1955 *B*.

Dr. Maas Geesteranus kindly examined our species from the Negev and drew our attention to the lobate circumference of the thalli and the paraplectenchymatous upper cortex. On account of these features this species has to be placed in the section *Gasparrinia*. According to Geesteranus it is nearest related with *Caloplaca decipiens* of this section.

After comparing our material with *C. decipiens*, we came to the conclusion that this specimen from the Negev is a new species, which differs from *C. decipiens* in the following characteristics: 1) The manner of growth is different. In *C. decipiens* the lobes are swollen and are arranged in a radiate form, most of them remain entire and not sorediate, whereas the lobes of our species are not swollen, wholly sorediate and arranged in a circular way. 2) Because of their radiate arrangement the lobes of *C. decipiens* do not form an organic depression, whereas our specimen forms an organic-cupshaped depression, because of the circular arrangement. 3) The depressions in our specimen are always grey-pruinose. A grey pruina at times covers the lobes of *C. decipiens* too, but never occurs in the middle and is not associated with any depression. 4) The apothecia are much smaller (250–300μ), than

those of *C. decipiens* which are usually ca 500μ and sometimes 900μ. 5) The margin is nearly biatorine, whereas in *C. decipiens* the margin is typical lecanorine. 6) In the paraplectenchymatous cortex it is nearly impossible to recognize its origin from perpendicular hyphae, whereas in *C. decipiens* many separate, perpendicular hyphae, which do not enter in a structural fusion can be distinguished.

We think that Flagey's specimen No 64 *Caloplaca citrina* from Algeria belongs to the new species too, showing an inclination to the cup-shaped thalli with a pruinose center and lobate circumference, which gets sorediose with age. The thallus is lemon-green and has a paraplectenchymatous cortex too.

Caloplaca ehrenbergii (Muell. Arg) A. Zahlbr.

A. Zahlbr. in Cat. Lich. univer. 7: 231. 1931. — *Amphiloma ehrenbergii* Muell. Arg. in Rev. Mycol. 2: 41. 1880.

N: On flint, Bir Hafir, 3.5.1929 *R*; 4 km from the starting point of the "Petroleum Road", 6. 1949 *L*; Nitzana, 1955 *H*; near Sdeh Boker, 14.12.1956 *MG*; "White Rock Hills", 12.11. 1956 *MG*.

Distribution

C. ehrenbergii is known only from the desert regions of Egypt, where it was collected by Ehrenberg and described by Mueller Argo (1880) as *Amphiloma ehrenbergii*.

Both in the Negev and in Egypt it is limited to the Saharo-Sindian regions — and is, as already mentioned by Reichert, (1937) an indicator for this phytogeographical region.

Caloplaca aurantia (Pers.) Hellb. var. *aurantia* Poelt (?)

Poelt in Mitteil. bot. Staatssamml. Muenchen, 19–20: 1954. — *C. aurantia* Hellb. in Bihang. till Kgl. svensk. Vetensk—Akad. Handl. 16, Afd. III, No. 1: 60. 1890. — *Lichen aurantius* Pers. in Usteri, Neue Ann. Bot. 5 Stueck: 14. 1794.

N: On various kinds of limestone (crystalline limestone, crystalline grey dolomite, etc.) Tel el Milek, 14.3.1956 *MG*; 22 km of Beersheva (beyond Wadi Aroer), 43 km of Beersheva near the Beersheva-Nitzana road, 17.3.1947 *G*; Mamshit (Kurnub). 17.3.1947 *G*, 6. 1949 *L*; Bir Hafir, 3.5.1929 *R*; Shivta, 14.12.1956 *MG*; Sdeh Boker (direc. Wadi Fukra) 3.1956 *ML*; at the foot of Mt. Ramon, 29.4.1957 *EG*; "White Rock Hills", 12.11.1957 *MG*; near Dimona, near Sdeh Boker and Mizpeh Ramon, 14.4.1959 *MG*.

Distribution

C. aurantia var. *aurantia* is, according to Poelt (1954) common in southern Europe and in warmer localities of central Europe.

The specimens of the Negev are, according to the same author, who kindly examined some of them, xeric modificants of *C. aurantia* var. *aurantia*. Examining the specimen which Flagey determined as *Placodium callopisma* Merat (No. 50 Flagey's Lichenes Algerienses) we found it to be identical with the specimens from the Negev. This specimen was collected near Constantine (Algeria) on calcareous substrate. Flagey (1896) states that he found this same lichen sometimes on siliceous substrate ("...beaucoup plus rare sur la silice"). On account of our observations we can say that as *C. aurantia* var. *aurantia* is characteristic of calcareous substrate we must assume that the lichen Flagey had found on "silice" must have been a different lichen. An-

other more probable possibility is that Flagey found his lichen on flinty limestone and *C. aurantia* var. *aurantia* developed on the calcareous part of it.

Caloplaca fulgens Koerb.

Koerb. in Abhandl. schles. Gesell. fuer vaterl. Kultur 2 Heft: 31. 1862.
N: On loess, near Ovdat, 28.3.1945 *Z.*

Distribution

C. fulgens appears (Suza 1937) nearly always together with *Lecanora lentigera* and therefore has a more or less analogous distribution area. According to Fink (1935) *C. fulgens* was found in South Dakota and Nebraska northwestward to Montana and in California. *C. fulgens* was not cited from these localities by any other author.

Buellia sorediosa I. Reichert et M. Galun sp. nov. Figure 7

Thallus tenuissimus, glaucescens, ± orbicularis, areolatus, dense sorediosus, soredia punctiforma, areolae minutae et secedentes. Hypothallus niger. Apothecia rara, adnata, disco nigro, leviter concavo vel plano, non pruinoso, margin proprio atro et permanente. Hymenium gelatinosum. Hypothecium superne fuscus, inferne fusco-nigrescens. Epithecium gelatinosum, viride. Paraphyses rectae, non septatae, apice non incrassatae. Sporae fuscae, diblastae.

Thallus very thin, forming 1–2cm large ± orbicular areas, many of them approximating, delimited by a black 1–1.5mm broad hypothallus; thallus areolate, areolae minute, densely arranged, disintegrating mainly in the centre, greenish-grey with a yellowish tinge, densely sorediose, soredia punctiform (Du Rietz 1924), KOH + yellow.

Apothecia rare or lacking, ± adnate, max. 685μ in diam.; disc black, convex or plane, proper margin prominent, black, 30–46μ thick. Hymenium gelatinous, 93–140μ high. Hypothecium 78–110μ high, upper part brown, lower part blackish-brown. Paraphyses and asci blue with I–IK. Epithecium gelatinous, greenish. Paraphyses simple, 1.5μ thick. Spores brown, one-septate, one cell somewhat broader: (7.5)–6×18μ.

N: On flint, Bir Hafir, 3.5.1929 *R*; 4 km from the starting point of the "Petroleum Road", 1949 *L*; 2 km South of Rosh Zohar, 10.9.1955 *EG*; near Dimona, 14.4.1959 *MG*.

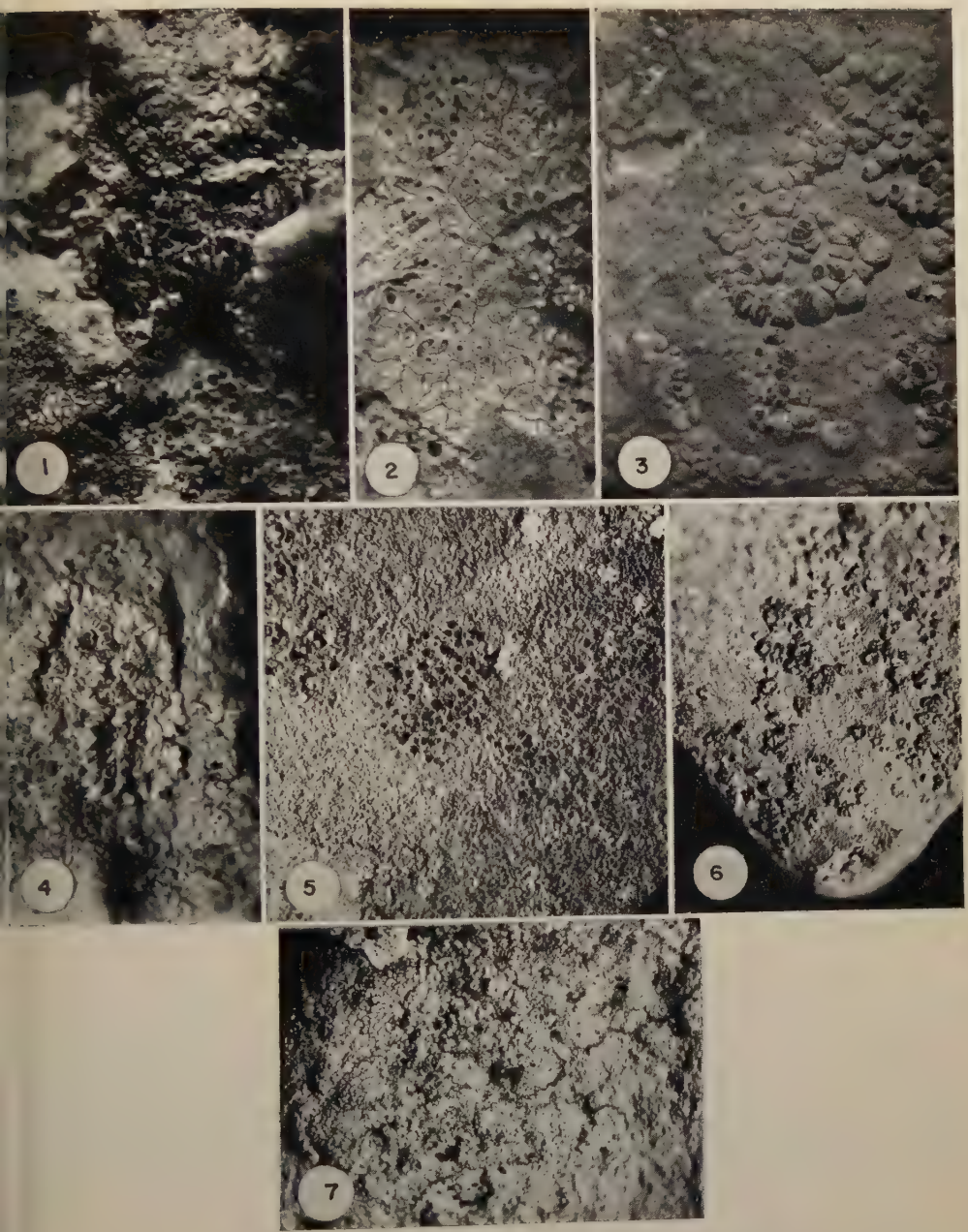
It seems to deserve the rank of a new species because it does not agree with any soredious species of the *Eubuellia*-group to which it belongs.

Buellia subalbula (Nyl.) Muell. Arg. var. *fuscocapitellata* I.M. Lamb

I.M. Lamb in J. Bot.: 350. 1936. — *B. subalbula* Muell. Arg. in Rev. Mycol. 2: 79. 1880. — *Lecidea subalbula* Nyl. in Bull. Soc. Linn. Normand. 2 Ser. 2: 516. 1868.
N; On crystalline limestone, Mamshit (Kurnub), 17.3.1947 *G*; on calcareous stones, near Dimona, 14.4.1959 *MG*; on flint, "White Rock Hills", 12.11.1957 *MG*.

Distribution

B. subalbula was described for the first time from Angola, by Nylander 1864. In 1880 another specimen from Jebel Dukhem (Egypt) was identified by Mueller Argo. Lamb (1936) describes a similar specimen from the Bahrein Island, which has paraphyses with brown apices, and therefore considered it a new variety — *fuscocapitellata*.



1. *Dermatocarpon convexum* sp. nov.
2. *Diploschistes tenuis* sp. nov.
3. *Acarospora areolata* sp. nov.
4. *Lecanora negevensis* sp. nov.
5. *Candelariella minuta* sp. nov.
6. *Caloplaca negevensis* sp. nov.
7. *Buellia sorediosa* sp. nov.

Although there are some differences in structure between the specimen from the Negev and Lamb's material, they still belong to the same species and variety. In our specimens the thallus is somewhat thicker, the apothecia reach 500μ (against 400μ), the hymenium is somewhat higher, the spores are not arranged in two rows in the asci, as in Lamb's material, but are in an irregular position.

Zahlbruckner (1903) described a new variety — *adriatica* — of the species *B. subalbula*, on account of smaller convex apothecia, and shorter, but broader spores. These characters do not justify a new variety, but Zahlbruckner's description of his lichen does not agree at all with *B. subalbula* for various reasons. First the reaction of the hypothecium with KOH is, according to Zahlbruckner, negative, while it is purple in *subalbula*. Then he mentions that the paraphyses are unseptate and unbranched, whereas in *subalbula* they are septate and sometimes branched. The spores in *adriatica* are constricted at the septum, while in *subalbula* they are not. We believe, therefore, that Zahlbruckner's lichen does not belong to *B. subalbula*.

Buellia canescens De Not.

De Not. in Giorn. bot. ital., anno II, parte I, 1: 197. 1846.

N: On flint, Bir Hafir, 3.5.1929 *R*; 4 km from the starting point of the "Petroleum Road", 6.1949 *L*; 2 km S. of Rosh Zohar, 10.9.1955 *EG*; near Sdeh Boker, 14.12.1956, "White Rock Hills". 12.11.1957 *MG*.

Distribution

This is a pecular species, which grows on trees and stones in the warmer localities of western Europe and in the Mediterranean countries. In Israel it has been found on olive trees (Reichert and Galun 1958). By the methods so far used for lichen identification, no differences between the specimens growing on trees and those growing on stones can be pointed out.

Buellia epigaea (Pers.) Tuck.

Tuck. Genera Lich. 185. 1872 — *Lichen epigaeus* Pers. apud Ach. Lichenogr. suec. Prodrom.: 105. 1798.

N: On loess, Great Canyon, 12.11.1957 *MG*.

Distribution

B. epigaea has been found in the United States in Nebraska, Wyoming and Montana and is known in Europe from Switzerland and eastern England. According to Koerber (1855) it grows on sandy soil and localities exposed to sunshine. Hepp (1853) states that *B. epigaea* grows in the United States and in Europe on calcareous soil together with the xerophilic lichens *Lecidea decipiens* and *Caloplaca fulgens*. Steiner (1921) mentions this lichen from the desert near Kaijim in eastern Syria, and Faurel, Ozenda and Schotter (1953) from El-Kantara (Algerian Sahara).

Buellia venusta (Koerb.) Lett.

Lett. in Hedwigia 52: 244. 1912. — *Diplotomma venustum* Koerb. Parerg. Lich.: 179. 1865.

N: On flint, 22 km SE of Beersheva (beyond Wadi Aroer), 17.3.1947 *G*; Bir Hafir, 3.5. 1929 *R*; Shivta, 10.9.1956 *EG*; near Dimona and Sdeh Boker, 14.4.1959 *MG*; "White Rock Hills", 12. 11.1957 *MG*; at the foot of Mt. Ramon, 29.4.1957 *EG*.

Distribution

B. venusta is known from Cyprus, Bavaria, Carpathian Mountains, and Gotland (Koerb. 1865), Morocco (Werner 1937), Greece (Steiner 1919), Iraq (Steiner 1921), Egypt (Delile 1813), Persia (Steiner 1916), Czechoslovakia (Servit 1929), New Mexico (Bouley de Lesdain 1932).

Olivier (1899) reduced the species *B. venusta* created by Koerber (1865) to a variety. Steiner (1916) accepted Oliveir's opinion and pointed out, for the first time, that the medulla gives sometimes a positive (red) reaction with KOH. We believe that it requires the rank of a species as assumed originally by Koerber (1865) and agreed to afterwards by Lettau (1912), although it is closely related to *B. epipolia*, differing from it however by the more convex apothecia and by the pseudothalline margin, in addition to the positive (red) reaction of the medulla with KOH.

Buellia epipolia (Ach.) Mong.

Mong. in Bull. Acad. intern. Georg. bot. 9: 242. 1900. — *Lecidea epipolia* Ach. in Lichenogr. univer: 186. 1810. — *Diplotomma albo-atrum* var. *epipolium* Mass. in Schedul. crit. 10: 186. 1856. Koerb. Parerg. Lich.: 178. 1860.

N: On calcareous stones, near Rosh Zohar, 14.3.1956 *MG*; near Dimona and Sdeh Boker, 14.4.1959 *MG*; "White Rock Hills", 12.11.1957 *MG*.

Distribution

Morocco (Werner 1937), Tunis (Exs. Brit. Mus. Herb. det. M. Lamb), Algeria Flagey's Lichenes Algerienses (Exs. No. 162), southern Turkey (Steiner 1921), Crete (Zahlbruckner 1906), Aegaean Island (Servit 1931), Greece (Steiner 1919), Dalmatia (Exs. Farlow Herb. 1908 det.: Zahlbruckner, Zahlbruckner 1909 b), Italy (Exs. Farlow Herb. coll.: Sbarbaw 1921, det.: Bouley de Lesdain; Erbar. Crittog. Ital. No. 682 coll.: Ferrari), Corsica (Zschake 1927), Iraq (Steiner 1921), Macedonia (Bornmüller 1928), Moravia (Suza 1925), Central Carpathians, Silesia, Bavaria, Franconian Jura (Koerber 1865).

Rinodina bischoffii Mass.

Mass. Framm. Lich.: 26. 1555.

N: On flinty limestone, Bir Hafir, 20 km S. of Beersheva. 3.3.1929 *R*; 22 km SE. of Beersheva (near Wadi Aroer). 17.3.1947 *G*; 4 km from the starting point of the "Petroleum Road", 6.1949 *L*; on calcareous stones, 43 km S. of Beersheva, 17.3.1947 *G*;"White Rock Hills", 12.11.1957 *MG*. near Dimona and Sdeh Boker, 14.4.1959 *MG*.

Distribution

Dalmatia (Zahlbruckner 1919), Greece (Steiner 1898, 1919), northern Algeria (Flagey 1896), Morocco (Werner 1955), Iraq (Steiner 1921), Syria (Werner 1956), Algerian Sahara: Biskara and El Kantara (Faurel, Ozenda and Schotter 1953), Moravia (Suza 1925).

Rinodina mediterranea Flagey

Flagey in Cat. Lich. Algérie: 40. 1896 — *Lecanora bischoffii* var. *mediterranea* Stzbrg. in Bericht über d. Thätigk St. Gallisch. naturw. Ges. 211. 1889–90.

N: On calcareous stones, Great Canyon, 12.11.1957 *MG*.

Distribution

R. mediterranea is a rare lichen. It was collected once in Algeria (Flagey's Lichens Algerienses) and is known from two places in Greece — Mycenae and Livadhi (Steiner 1919).

This lichen was described by Stitzenberger in 1888 as *Lecanora bischoffii* var. *mediterranea*. Flagey (1896) gave it the rank of species, which was not accepted by Harmand (1913).

Comparing the descriptions of the two lichens given by Flagey and Harmand enough differences may be noticed, which justify the separation of these lichens into two species. 1) *R. bischoffii* has a more developed thallus. 2) The thalline margin of the apothecia is permanent in *R. bischoffii* and disappearing in *R. mediterranea*. 3) The apothecia of *R. mediterranea* are at the most 0.5 mm in diam., while those of *R. bischoffii* reach 1.5mm.

After reexamining Flagey's original material (Lichenes Algerienses, Exs. No. 230 *R. bischoffii*, Exs. No. 89 *R. mediterranea*), we can add two more differences between the two lichens: 1) The apothecia of *R. bischoffii* are more prominent. 2) The central part of the excipulum in *R. bischoffii* is composed of long-celled hyphae, while this part of the excipulum in *R. mediterranea* consists of rounded cells forming a plectenchymatous tissue.

Fam. *LECIDEACEAE*

Lecidea decipiens Ach. f. *dealbata* (Mass.) Jatta

Jatta, Syll. Lich. Ital.: 308. 1900 — *L. decipiens* Ach. Method. Lich.: 80. 1903 — *Psora decipiens* f. *dealbata* Mass. apud Rabh. Flecht. Europ. 12: 345. 1858.

JD: On loess, betw. Jerusalen and Jericho, s.d.*K*; near Ovdat, 28.3.1945 *Z*; 68 km ESE. of Beersheva, near Wadi Fukra, 17.3.1947 *G*; Great Canyon, 12.11.1957 *MG*.

Distribution

Tripolitania (Mameli 1913, Romano 1911), Dalmatia (Zahlbruckner 1919a).

The lichen belongs to f. *dealbata* because of the white pruina of the squamules.

Fam. *TELOSCHISTACEAE*

Xanthoria isidioidea (Beltr.) I. Reichert et M. Galun, comb. nov.

N: On flint, 2 km S. of Rosh Zohar, 10.9.1955 *EG*; on grey crystalline dolomite, Tel el Milek, 14.3.1956; on calcareous stones, Mamshit (Kurnub), 17.3.1947 *G*; on crystalline limestone, near Sdeh Boker (in the direction of Wadi Fukra), 3. 1956 *ML*; on grey crystalline limestone, Shivta, 14.12.1956 *MG*; Wadi Taut. 1957 *N*; near Sdeh Boker, Mizpeh Ramon, 14.4.1959.

Dr. Poelt kindly examined one of our specimens and drew our attention to its relation with *X. parietina* var. *isidioidea* (Beltr.) and *X. aureola* (Ach.) Erich.

Our specimens are perhaps in closer relation with *X. parietina* var. *isidioidea*, because of the numerous granuliform isidia covering the thallus — which are not to be seen in *X. aureola*. The lichen from the Negev is a typical xerophylous plant whereas *X. parietina* var. *isidiodea* is known from localities in the Mediterranean countries where the humidity is relatively high. We believe therefore that the specimens from the Negev should be recognized as *X. isidiodea* comb. nov.

Teloschistes brevior (Nyl.) Wain. f. *halophilus* (Elenk.) Oxn.

Oxn. in Bull. Jard. bot. de Kieff, livr. IIV–VIII: 71. 1928 — *T. brevior* Wain. in Act. Hort. petropol. 10: 552. 1887.— *Physcia brevior* f. *halophila* Elenk. in Bull. Jard. imper. bot. Peterb. livr. II: 62. 1902. —

P. villosa f. *brevior* Nyl. in Lich. a cel. Ehrenb. in Aegypto coll.: 61. 1864. —

N: On loess, 25 km SE. of the Dimona Road, 10.4.1957 *H*; near Sdeh Boker, 14.4.1959 *MG*; near Ovdat, 28.3.1945 *Z*; "White Rock Hills", Great Canyon, 12.11.1957 *MG*.

Distribution

T. brevior has been found by Ehrenberg and Schweinfurth in Egypt on *Lycium arabicum* and by Wainio on *Juniperus* and *Amygdalus*. Forma *halophilus* on the other hand, is a specific soil lichen. According to Elenkin (1901) this is a "Wanderflechte" characteristic of steppes and deserts. Hillman (1930) mentions it from the salt desert of Russia. Magnusson (1940) determined specimens of *T. brevior* growing on soil from Central Asia. We believe that he had before him the *halophilus* form and not the species itself.

Fam. *USNEACEAE*

Ramalina maciformis (Del.) Bory

Bory in Dictionn. Class. Hist. nat. 14: 457. 1828. *Parmelia maciformis* Delile Descript. de l'Egypte 2: 288. 1813.

N: On flint, Bir Hafir, 3.5.1929 *R*; 4 km from the starting point of the "Petroleum Road", 6.1949 *L*; 2 km S. of Rosh Zohar, 10.9.1955 *EG*; near Sdeh Boker, 14.12.1956*MG*; "White Rock Hills", 12.11.1957 *MG*

Distributions

Delile (1813) collected *R. maciformis* in Mokattan-Egypt. In 1857 it was collected by Figari in the same place, in the Mariotti desert near Alexandria and in Petra. Jatta (1891) quotes *R. maciformis* from southern Italy and Sicily. According to Reichert (unpublished) who examined Jatta's material, the specimens from Italy and Sicily do not belong to *R. maciformis*. Lamb (1936) has seen *R. maciformis* from North Afrika, Israel, Arabia and Bahrein Island.

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CORRIGENDUM

p. 270, Figure 6; For June at foot of Figure *read* July.

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